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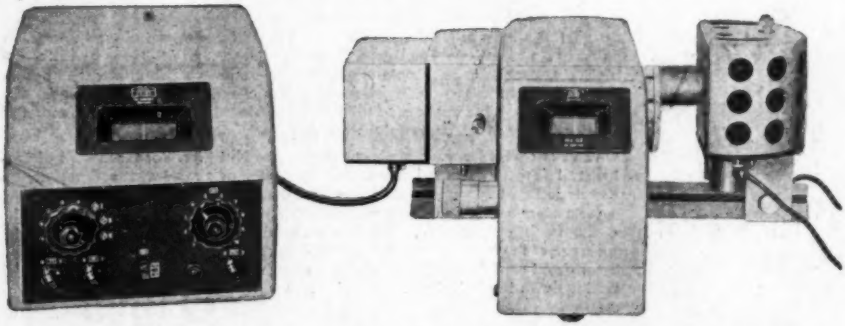

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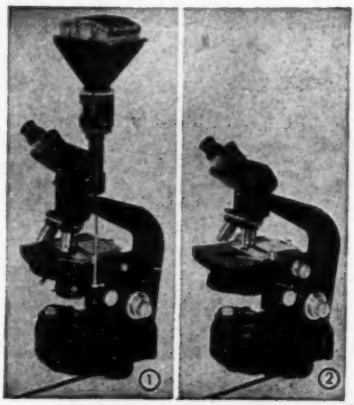

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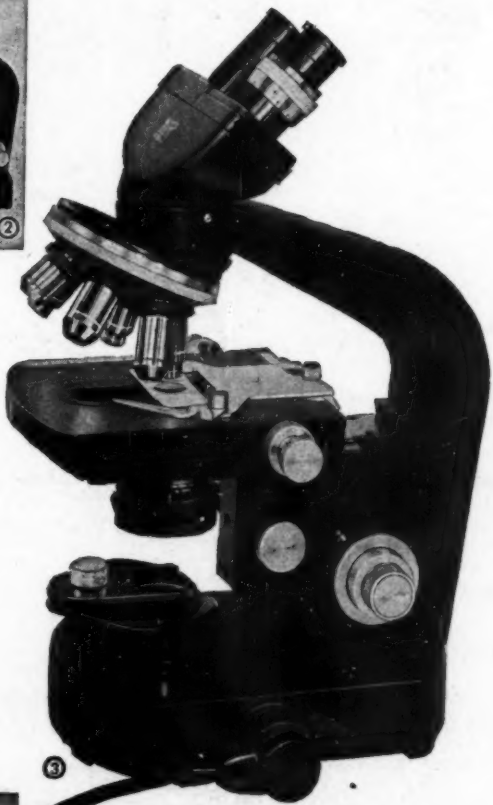

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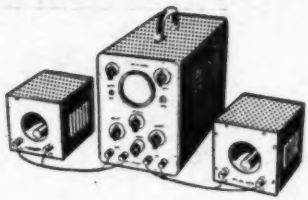

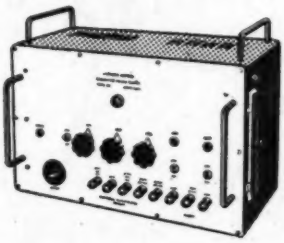

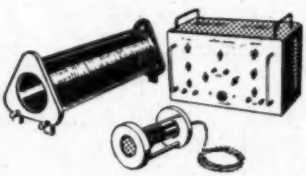

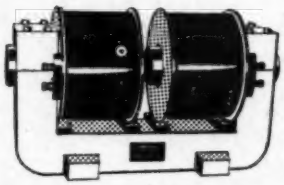

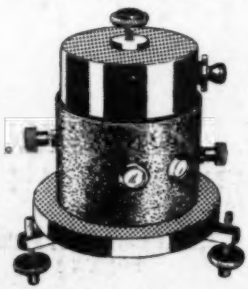

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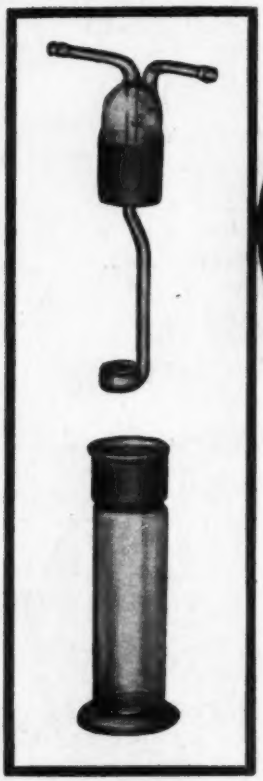

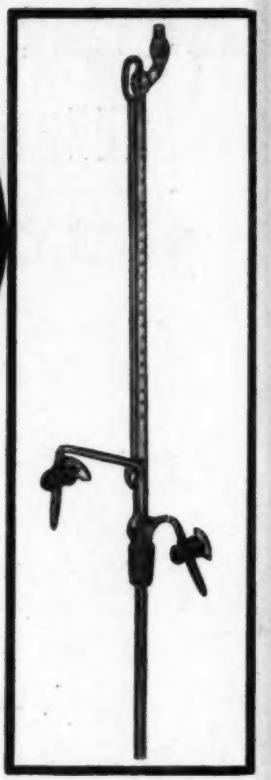

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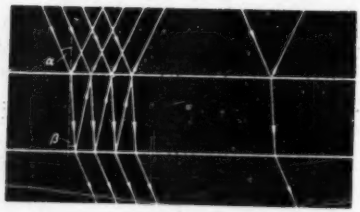

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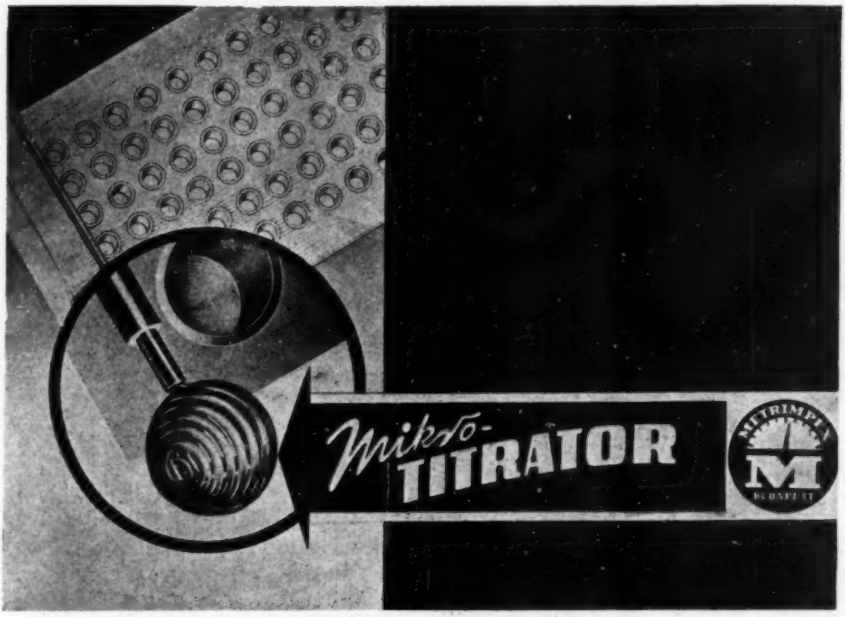

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CHEMISTRY AND THE SPECTROSCOPE*

R. G. W. NORRISH, F.R.S.

Department of Physical Chemistry, University of Cambridge, England

THE fundamental and detailed work conducted in laboratories must, by its nature, remain sometimes obscure to non-scientists and in some cases even to those who specialise in other branches. Yet it is indirectly of importance to everybody.

For example, flash photolysis and "kinetic spectroscopy", discovered and developed in the Laboratory of Physical Chemistry at the University of Cambridge, England, is a new and powerful method of studying the intimate nature of photo-chemical and thermal reactions over periods measured in millionths of a second. Its applications are immensely varied.

It provides means of examining the nature of explosive processes; can be applied to the study of anti-knock additives in the internal combustion engine; it yields important information about the elementary reactions in the upper atmosphere of vital value to the meteorologists and geochemists and the processes which are now believed to have created the environment on which life, as we know it, depends.

The new method yields objective information about the free radicals and other transient intermediates taking part in photo-chemical and thermal reactions. These intermediates generally have very short lives, measured in millionths of a second; nevertheless it has been possible to photograph their characteristic spectra at successive intervals of time and so to measure the rates of their growth and decay during chemical reaction. Sometimes they are produced in a highly energised state of thermal vibration, yet "cold" as regards their translational and rotational motions, and the study of this has thrown light on the propagation of chain reactions, and the transfer of energy from vibrational to other thermal degrees of freedom.

A Paramount Challenge

The "kinetic spectroscopy" method involves the use of the photo-chemical technique of flash photolysis. It was discovered and developed spectroscopically in our Laboratory of Physical Chemistry at Cambridge, as I shall presently describe.

The principles of photo-chemical reaction were first conceived some 50 years ago through the work of Warburg, Bodenstein, Henri and Weigart and took final shape through the work of others who followed. Into the whole framework have been fitted innumerable photochemical and thermal reactions whose postulated mechanisms, involving atoms-free radicals or excited species, are entirely derived from the circumstantial evidence afforded by spectroscopic observations and quantitative measurements involving photo-chemical kinetics, and end products. In general, the consistency of the mechanisms within the framework is so good as to lead to confidence in our conclusions, though the absence of any objective proof of the existence of the postulated intermediates has constituted a permanent challenge to the photochemist, and sometimes gave rise to criticism from unbelievers which weakened his position.

It was for this reason that in 1946 we decided to break new ground by endeavouring to obtain direct spectroscopic evidence for the free radicals postulated as intermediates in photo-chemical reactions. This was made possible by the discovery by Porter and myself that very large measures of photolysis could be achieved by the application of a powerful light flash to suitable reactants, such as nitrogen peroxide, iodine, or acetone, contained in a quartz vessel. These early flashes produced by discharging a bank of condensers through argon were of 1-2 milliseconds duration and dissipated up to 10,000 Joules of energy, and it seemed obvious that if free radicals were produced in the reactions, they must momentarily have been at such very high concentrations as to invite efforts to photograph their absorption spectra.

First Achieved in 1949

This was achieved in the first instance by Porter in 1949, who, using a second flash as a photographic source triggered mechanically at short intervals after the first by the method of Oldenburg, was able to demonstrate the dissociation of chlorine and to obtain the spectrum of the CS radical by the photolysis of carbon disulphide. This early success was followed by the development of the technique; shorter photolysis flashes of 100 microseconds duration and of 1,000-3,000 Joules were devised, and shorter intervals between the photolysis flash and spectroscopic flash were achieved by using electronic delay circuits capable of precision timing to a few microseconds.

* Based on his Presidential Address to the Chemistry Section of the British Association for the Advancement of Science's Annual Meeting at Norwich, August and September, 1961.

It soon became apparent that the early results of flash photolysis in the gaseous systems which I have previously exemplified were vitiated by a great rise of temperature, which resulted in thermal as well as photo-chemical dissociation. This arises from the fact that when the intense flash is applied to a suitably absorbing system such as chlorine, or nitrogen peroxide, the absorbed light energy is rapidly degraded to heat: it may be calculated that a reactant at a pressure of 1 mm. absorbing one-thousandth of the emitted energy will instantaneously reach a temperature measured in some thousands of degrees. Only if a relatively large excess of inert gas (say 500 mm. pressure) is present to act as coolant, or the process is carried out in solution, can this temperature rise be kept in check, and so limited to a few—say ten degrees in the case of a gaseous system. Thus under the adiabatic conditions resulting from lack of temperature control thermal cracking or explosion as well as photolysis may be induced in suitable systems and the method of kinetic spectroscopy provides a valuable means for the observation of the rapid elementary reactions of free radicals or atoms occurring in explosive media initiated photo-chemically.

Comprehensive Method

We therefore have a comprehensive method which can be applied to "instantaneous" reactions in the gas phase both under adiabatic and isothermal conditions, and also to reactions in solution.

Applications are legion. The very short ultra-violet rays of the sun which do not penetrate our atmosphere bring about reactions in the upper atmosphere, giving rise to the protective ozone layer and involving atoms and free radicals of the utmost importance to the geochemist and meteorologist; much information can be obtained about these in the laboratory by the methods I have described.

It is now believed that the primitive atmosphere of the earth was reducing, composed mainly of hydrogen, together with methane, hydrogen sulphide, water, carbon monoxide and ammonia, similar to the atmospheres of the major planets as we see them today. If the solar system had a uniform origin there must have been influences which changed our atmosphere and that of Mars from reducing to oxidising. The first is the progressive loss of hydrogen from our relatively weak gravitational field. The second is the photolysis of water and the other compounds, leading to the formation of formaldehyde and oxides of sulphur, phosphorus and nitrogen, which on interaction, according to the fascinating views of Urey and Oparin, deposited the primordial organic scum on the earth and provided the necessary medium for the evolution of life.

Many of the reactions involved can be studied by flash photolysis. Others such as the photolysis of water, methane and other hydrocarbons lie at present outside its scope, and provide a challenge to extend this powerful method to shorter wavelengths of the ultra-violet which at present escape us.

Note: Full references to the work cited are to be found attached to the report of the full address published by the British Association.

SUCCESSFUL OPERATION OF *NIMROD* INJECTOR

ON August 1 the first proton beam accelerated to the design energy of 15 MeV. was obtained from the linear-accelerator injector which forms the first stage of *Nimrod*, the 7,000 MeV. proton synchrotron under construction at the Rutherford High-Energy Laboratory of the National Institute for Research in Nuclear Science, Harwell. The linear accelerator consists of a cylindrical copper cavity approximately 44 ft. long and 5·5 ft. in diameter, with 48 drift tubes spaced along its axis, the whole being enclosed in a vacuum envelope. Approximately 1 MW. of radio-frequency power is supplied to the cavity at its resonant frequency of 115 Mc./s. to set up the required accelerating fields across the gaps between drift tubes. The function of the drift tubes is to screen the protons from the field when its direction reverses every alternate half-cycle, and they also contain focusing magnets which constrain the protons to form a proper beam close to the machine axis. The drift tubes increase in length along the tank to correspond with the increase in proton velocity. Protons enter the linear accelerator with an initial energy of 0·6 MeV. from a pre-injection stage which is basically a conventional d.c. accelerator. Pulsed 15 MeV. beams will be delivered by the injector to the synchrotron at rates up to 2 per sec. and at pulse lengths up to 2 m. sec. Within the synchrotron, they will be constrained to a circular path by a suitably varying magnetic field. In this way they will make many revolutions, receiving a small acceleration at a particular point in the orbit until the output energy of 7,000 MeV. is reached. Construction work on *Nimrod* started in August 1957 and is expected to be completed during 1962.—(*Nature*, p. 1,043, Vol. 191, September 9, 1961.)

ON SOME METHODS OF CONSTRUCTION OF ASYMMETRICAL FACTORIAL DESIGNS

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1. Introduction

KISHEN AND SRIVASTAVA[1,2] have given general methods of construction of asymmetrical factorial designs and Kishen[3] has discussed the method of constructing optimum designs of the class $q \times 2^2$. Some further optimum designs of the class $q \times 2^2$ and various methods of constructing different types of asymmetrical factorial designs which have since been developed are briefly discussed in this article.

2. Further Optimum Designs of the Class $q \times 2^2$

It has been demonstrated by Rao[4] that for $q = 13$, a BIB design with $v = 13$, $b = 26$, $k = 6$, $r = 12$, $\lambda = 5$ exists. This design, as in the case of the BIB designs associated with the 5×2^2 and 9×2^2 designs, can be split up into two PBIB designs with parameters $v = 13$, $b = 13$, $k = 6$, $r = 6$. Consequently, writing X_0 in the pattern of one of the PBIB designs in 13 blocks and filling the remaining 7 places in each block with X_1, and then writing X_1 in the pattern of the other PBIB design in 13 blocks and filling the remaining places with X_0, we obtain an optimum balanced design for 13×2^2 in 26 blocks of 26 plots each. This method was indicated by M. N. Das also, in a paper presented at the Fourteenth Annual Meeting of the Indian Society of Agricultural Statistics. As in the case of the 5×2^2 and 9×2^2 designs in 10 blocks and 18 blocks respectively, this design is non-resolvable.

It has been shown by Rao that for $q = 23$, 27 and 31, BIB designs with $b = 23$, 27 and 31, and $k = 11$, 13 and 15 exist. Consequently, for the cases 23×2^2, 27×2^2 and 31×2^2, optimum designs in 46, 54 and 62 blocks of 46, 54 and 62 plots each respectively have been obtained. Rao has also given solutions for BIB designs with parameters $v = 12$, $b = 22$, $k = 6$, $r = 11$, $\lambda = 5$, and $v = 16$, $b = 30$, $k = 8$, $r = 15$, $\lambda = 7$; by use of which optimum designs in the cases 12×2^2 and 16×2^2 in 22 and 30 blocks of 24 and 32 plots each respectively have been constructed.

3. Use of Pseudo-Factors

Designs of the type $l \times s^2$, where $l = s^m$, m being any prime positive integer, in blocks of ls plots each can be constructed by taking the first factor as equivalent to all combinations of m pseudo-factors, each at s levels. By this procedure, optimum balanced designs can be constructed in a minimum of $(l-1)$ replications, or $(l-1)\,s$ blocks of ls plots each, each replication being comprised of s blocks. Balancing is achieved on $(l-1)(s-1)$ degrees of freedom for the interaction ABC. Thus, the 8×2^2 design in 7 replications, or 14 blocks of 16 plots each, is given by the 14 equations

$$\left.\begin{aligned} x_1 + x_2 + x_3 + x_4 + x_5 &= 0, 1 \\ x_1 + x_2 + x_4 + x_5 &= 0, 1 \\ x_1 + x_3 + x_4 + x_5 &= 0, 1 \\ x_2 + x_3 + x_4 + x_5 &= 0, 1 \\ x_1 + x_4 + x_5 &= 0, 1 \\ x_2 + x_4 + x_5 &= 0, 1 \\ x_3 + x_4 + x_5 &= 0, 1 \end{aligned}\right\}, \qquad (1)$$

where x_1, x_2 and x_3 correspond to the three pseudo-factors taken as equivalent to the first factor A, and x_4 and x_5 correspond to the second and third factors B and C. Taking X_0 and X_1 to denote, as before, the treatment combinations b_0c_0, b_1c_1 and b_0c_1, b_1c_0 respectively, the design would be as under:

Table I

8×2^2 *Design in 16-plot blocks*

A	I	II	III	IV	V	VI	VII
a_0	X_0 X_1	X_0 X_1	X_0 X_1	X_0 X_1	X_0 X_1	X_0 X_1	X_0 X_1
a_1	X_1 X_0	X_0 X_1	X_1 X_0	X_1 X_0	X_0 X_1	X_0 X_1	X_1 X_0
a_2	X_1 X_0	X_1 X_0	X_0 X_1	X_1 X_0	X_1 X_0	X_1 X_0	X_0 X_1
a_3	X_0 X_1	X_1 X_0	X_1 X_0	X_0 X_1	X_1 X_0	X_0 X_1	X_1 X_0
a_4	X_1 X_0	X_1 X_0	X_1 X_0	X_0 X_1	X_1 X_0	X_0 X_1	X_0 X_1
a_5	X_0 X_1	X_1 X_0	X_0 X_1	X_1 X_0	X_1 X_0	X_0 X_1	X_1 X_0
a_6	X_0 X_1	X_0 X_1	X_1 X_0	X_0 X_1	X_0 X_1	X_0 X_1	X_0 X_1
a_7	X_1 X_0	X_0 X_1	X_0 X_1	X_1 X_0	X_1 X_0	X_1 X_0	X_1 X_0

(2)

Similarly, the 9×3^2 design in 24 blocks of 27 plots each can be readily constructed, to which reference has been made subsequently.

4. Optimum Designs of the Class $q \times 3^2$

For balanced designs of the type $q \times 3^2$ in blocks of $3q$ plots each, in which the sets

"J_0, J_1, J_2," "J_1, J_2, J_0," and "J_2, J_0, J_1," where J_0, J_1, J_2 are the three sets of treatment combinations corresponding to BC (J), are repeated t_1, t_2 and t_3 times respectively in each replication, it can be shown that the loss of information on BC and ABC is given by

$$L(BC) = \frac{t_1^2+t_2^2+t_3^2-t_1t_2-t_1t_3-t_2t_3}{q^2} \quad (3)$$

and

$$L(ABC) = \frac{3(t_1t_2+t_1t_3+t_2t_3)}{q^2}, \quad (4)$$

where

$$t_1 + t_2 + t_3 = q,$$

the total loss of information thus being 2, which is the necessary condition for a balanced design in this case. Now q can be of the form $3t$, $3t-1$ or $3t-2$, t being any positive integer.

When $q = 3t$, the optimum design is given by

$$t_1 = t_2 = t_3,$$

L (BC) being 0. (5)

When $q = 3t-1$, the optimum design is given by

$$t_1 = t_2 = t,\ t_3 = t-1,$$

L (BC) being $1/q^2$. (6)

Finally, when $q = 3t-2$, the optimum design is obtained when $t_1 = t$, and

$$t_2 = t_3 = t-1,$$

L (BC) being $1/q^2$. (7)

A balanced design cannot be optimum unless each of the replications follows one of the three patterns discussed above.

The procedure of pseudo-factors discussed in Section 3 gives optimum designs for the class of $l \times 3^2$ designs in which each of the three sets "J_0, J_1, J_2," etc., occurs $l/3$ times in a replication and L (BC) = 0. It would thus follow that where resolvable BIB designs with parameters $v = l$, $k = l/3$, b, r, λ exist, these would yield optimum balanced designs of the class $l \times 3^2$. Such BIB designs are known to exist for $l = 6$, 9 and 12, which thus enables construction of optimum 6×3^2, 9×3^2, 12×3^2 designs in 18, 27 and 36 plot blocks respectively.

It would also be seen that where resolvable BIB designs with parameters $v = sp$, $k = p$, b, r, λ exist, these enable construction of optimum balanced designs of the class $q \times s^2$, where $q = sp$. In this manner, the designs 10×5^2, 12×4^2, 15×5^2, 21×7^2 and 28×7^2 in blocks of 50, 48, 75, 147 and 196 plots respectively are readily obtained.

5. Method of Cutting

The method of cutting given by Kishen and Srivastava[2] and also independently by M. N. Das (unpublished) is a useful device for obtaining balanced asymmetrical factorial designs. However, it appears that for designs of the type $q \times s^2$, where $q = sp$, p being any integer, adopting a single cut, that is, cutting out in all the blocks all the treatment combinations which contain the last level of the factor A, gives an optimum design. Thus, from 8×2^2 design given in Section 3, the optimum 7×2^2 design is obtained by omitting all the treatment combinations involving a_7, i.e., the last row of the design. This, in fact, is the design obtained from the associated BIB design with $v = b = 7$, $k = r = 3$, $\lambda = 1$. However, when we have two cuts, that is, we omit the row containing a_6 also in this design, the resulting 6×2^2 design is no longer an optimum design, the loss of information on BC in this design being 1/21 when it should have been zero if it were optimum. With the adoption of three cuts, that is, omitting the row containing a_5 also, we get a balanced 5×2^2 design which again is not optimum, the loss of information on BC being 3/35 when this loss in the case of an optimum design is 1/25. All these designs involve 7 replications.

From the 9×3^2 design referred to in Section 3, we can by one cut obtain the 8×3^2 design, which is optimum, the loss of information on BC in this case being 1/64. However, with two cuts, we obtain a balanced 7×3^2 design which, however, is not optimum, the loss of information on BC being 1/28 instead of 1/49 if the design were optimum. With three cuts, we get a balanced design for 6×3^2 in which the loss of information on BC is 1/16, instead of zero in the case of an optimum design. With a further cut, we obtain a 5×3^2 design in which the loss of information on BC is 1/10 instead of 1/25 in the case of an optimum design. All these designs have eight replications.

It would thus appear that in the case of designs of the types $q \times 2^2$, where $q = 2u$, and $q \times 3^2$, where $q = 3u$, u being any positive integer, only a single cut results in an optimum design and that further cuts yield only balanced designs which increasingly deviate from the optimum as the number of cuts adopted increases. The method of cutting is thus only useful in providing balanced designs where the corresponding optimum designs do not exist. Two or more cuts, therefore, never lead to optimum designs for the construction of which other methods, some of which have been indicated in the earlier Sections, have to be adopted. It may, however, be remarked that the optimum 5×2^2 and 9×2^2 designs in 10 and 18 blocks of 10 and 18 plots each respectively, which are non-

resolvable, can be obtained direct from the optimum 6×2^2 and 10×2^2 designs by using a single cut.

6. Use of PBIB Designs

In any asymmetrical factorial design, the use of the associated BIB design usually results in a large number of replications. It is, therefore, necessary to use the associated PBIB designs for obtaining partially balanced asymmetrical factorial designs which lead to a marked reduction in the number of replications required for a completely balanced design. Thus, for instance, the partially balanced 6×2^2 design obtained by doubling the 3×2^2 design, requires only three replications instead of five replications required for the completely balanced optimum design. It is noticeable that in this partially balanced design, BC is unconfounded. Similarly, partially balanced designs for $q \times 2^2$, where $q = 4p$ $(p \geqslant 2)$, in three replications are obtainable from the completely balanced 4×2^2 design in three replications; and the partially balanced $q \times 3^2$ design, where $q = 3p$ $(p \geqslant 2)$, in two replications are derivable from the completely balanced 3×3^2 design in two replications. This technique, which has been given by Kishen and Srivastava,[2] thus enables a large class of practically useful partially balanced asymmetrical factorial designs to be constructed.

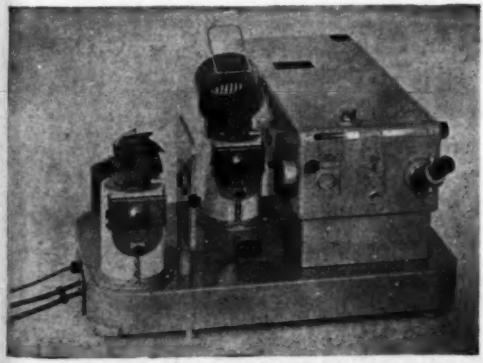
7. Designs of the Type $q \times t \times s$, where $t = s^m$

In this case, the $t \times s$ treatment combinations are divided into s sets corresponding to $s - 1$ degrees of freedom for the interaction BC. Then the problem of construction of optimum balanced designs in blocks of qt plots reduces to that of construction of optimum balanced designs for $q \times s^2$ in blocks of qs plots, methods of construction of which have already been discussed. Thus, for the $3 \times 4 \times 2$ design in blocks of 12 plots each, a balanced design is available, as in the case of the 3×2^2 design, in three replications. If, however, balance is desired on each of the three degrees of freedom belonging to the interaction BC, 9 replications would obviously be required.

1. Kishen, K. and Srivastava, J. N., *Curr. Sci.*, 1959, **28**, 98.
2. — and —, *J. Ind. Soc. Agric. Stat.*, 1960, **11** (1 and 2), 73.
3. Kishen, K., *Curr. Sci.*, 1960, **29**, 465.
4. Rao, C. R., *Sankhya*, 1961, **23 A**, 117.

THE INDUSTRIAL SPECTROSCOPE

IN the pavilion of the German Democratic Republic at the Second Indian Industries Fair being held from the 14th of November 1961 until the 1st of January 1962, VEB Carl Zeiss JENA is exhibiting amongst other products of their extensive production programme the Industrial Spectroscope which deserves special mention.



The Industrial Spectroscope has been designed in a way which permits its application in the various fields of industrial material testing, primarily for rapid spectrochemical analyses for all kinds of metals. The principal field of application for the Industrial Spectroscope is in the small and medium-sized industrial and research inspection laboratories, *e.g.*, in metal and semi-finished product stores, in annealing and tempering plants, in scrap yards and scrap reclaiming depots, foundry laboratories, metallurgical, metallographic and mining experimental stations and similar inspection points where the speedy recognition of the material quality is frequently of great economic importance. The following technical data will indicate its optical performance: high dispersion by two double-effective flint-glass prisms, D = 0·9 Å/mm. at 5,000 Å; the resolving power $\lambda/\Delta\lambda = 17{,}000$ at 5,000 Å means that 0·3 Å can still be discerned; large aperture ratio of 1 : 11; two different magnifications: × 8 for low-power viewing and × 22 for exacting observations; direct wavelength determination to ± 2 Å; the coarse motion ensures a rapid survey of the spectrum—precise setting with the aid of the fine motion; izochromatic photometric evaluation with a neutral wedge of high pitch, thus no loss in light-intensity by polarising filters; convenient reading of wavelengths and extinction on frosted screens; two attached spark stages within easy reach from the operator's place; rapid change of the counter-electrodes; self-contained rigid design.

EARTH TIDES

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AS the earth itself is an elastic yielding body, not only the marine surface, but also the earth's surface deforms due to the gravitational attractions of the sun and the moon. The elastic deformation of the earth, considered separately from the water on its surface, is called an Earth Tide. Because of its rigidity, earth will not quite reach the equipotential surface, as an ideal body of liquid of rigidity zero would do, but will assume an intermediate height, which will depend upon the elastic properties and the density of the earth. There is another factor 'g' which can be measured at any station, which is a function of density and physical properties of the material constituting the earth, in that region. In other words the deformation that the earth undergoes as a result of gravitational attraction between earth, sun and the moon are reflected in the values of 'g' at a given time. By using modern gravimeters with high sensitivity and accuracy, changes in the vertical component of earth tide, which has the amplitude of several 10^{-7} of the normal gravity unit (gal), can be recorded continuously permitting study and analysis of the gravity-time curve for a proper understanding of the problem of earth tides. The variation of the tidal forces and consequently the fluctuations in the gravity-time curve are essentially due to continuous changes in the position of the sun and the moon with respect to the earth, causing corresponding changes in the tide-generating force. A theoretical gravity-time curve can be constructed by assuming the positions of sun, moon and earth (observation point), average density of earth and a certain value for the rigidity of earth. A liquid sphere of the size and mean density of the earth, rigidity value zero and high compressibility would have a natural period of 94 minutes; on the other extreme an incompressible elastic sphere, of the density of the earth, rigidity of steel would have a natural period of 55 minutes. Earth being an intermediate case would fit into some position of the gravimetric spectrum depending upon the local geological structure. By comparing the theoretical and experimental curves and assuming certain conditions, the rigidity of earth can be approximately estimated. Study of earth tides seems to provide a powerful tool in understanding the nature and geological structure of regions where observations are being made.

As the tidal fields (variation in the Gravitational Value) are only of the order of 10^{-7} of the normal gravity field, on the earth's surface, it is a major experimental task to disentangle the different influences and to dissect the complicated observed data into different components. Experimental arrangements do not measure exclusively the primary earth tides but also some secondary effects which are mainly of oceanic origin and also include tectonic influences. The measurements therefore contain a complex sum of effects which can be characterised by vectors and the results can be expressed as a vectorial sum

$$M = KE + I + S$$

where KE is the direct effect which will be proportional to the equilibrium theoretical tide by a factor K characterised by the type of measurement and the elasticity of the earth. The indirect effects are contained in I which is of tidal periodicity and is mainly of oceanic origin, but may also include tectonic influences. S are the secondary effects, which can be written as a vectorial sum

$$S = S_G + S_M + S_T$$

where S_G is the effect of geological and tectonic structure, S_M is the meteorological pressure effect (including also maritime surges) and S_T is the effect of variations of temperature, that is, either direct effects on the instrument or secondary effects such as those due to strain influences in the earth's crust.

On the surface of the earth, observations have been made to study the variation of the numerical value of the earth's gravitational field at several points; its variation with time has been studied and causes for such variation have been analysed—the principal one caused by attraction according to Newton's Law, the second one caused by earth's rotation. The variations of the tidal forces due to the alterations of the astronomical elements of the moon and the sun can be expressed by the sums of cosine functions with constant amplitudes and frequencies, the amplitudes being only functions of the geocentric latitude of the observer and his distance from the earth's centre. The direction of the vertical component is taken as positive in the direction opposite to the normal gravitational field. The maximum of the tidal action therefore corresponds to a measured minimum of gravity.

While the semidiurnal fluctuations due to the moon and the sun are the most important, there are a great many other less important contributory factors which cannot be neglected in the understanding of the complete picture of the tidal fluctuations on the surface of the earth. Some of the most important semidiurnal and diurnal constituents which are used in the analysis of the earth tides are : Lunar Principal (M_2), Solar Principal (S_2), Lunar Elliptical (N_2), Lunisolar (K_2), Lunisolar (K_1), Lunar Declination (O_1) and Solar Declination (P_1).

The experimental data showing the variation of the vertical component of the gravity field with time can be subjected to either simple harmonic analysis, least square method or a modified Fourier Method after eliminating the drift by the Running Mean Method. The harmonically analysed results, specially the M_2 constituent, is generally the most reliable. The experimental drift-eliminated curve can now be analysed for the seven main tidal components, semidiurnal and diurnal mentioned above. The amplitudes of the seven components for both the curves can be compared and the ratio of the two amplitudes is very significant. Using this value the Rigidity of the Earth at the experimental station can be calculated. The earth tides at a particular station are dependent upon the Geological Structure, Internal Constitution of the Earth and Tectonic conditions. By comparing the experimental and theoretical tidal components we can also calculate the Phase Lag, Gravimetric Factor, Diminishing Factor, the Lambert's Constant and the three tidal Elastic Constants h, k and l, which characterise the elasticity of the earth, for a fuller understanding of the picture.

The six characteristic numbers, listed above, are functions of density and elasticity distributions in the interior of the earth. The comparison of the experimental tidal data with the values to be expected for a homogeneous, incompressible earth will show an incompatibility. In fact, taking this as a clue, several formal solutions for the inner structure of the earth have been given by many geophysicists. The influence of the oceans on the tidal values on continental stations is interesting to study. It has been observed that at a distance of 600 Kms. from the seashore the effect of the oceanic tides can be minimised to a large extent. Tomaschek summarised that the oceanic effects consist of three components : The gravitational attraction of the shifted water masses on the point of observation ; the deformation of the solid earth due to the shift of the water masses, and the change of potential due to the changed distribution of masses.

The meteorological influences are felt mainly in the temperature and pressure fluctuations ; both deform the earth's surface and the knowledge of these factors is of great importance. The main periodic influences of temperature are diurnal and to a lesser degree semidiurnal in period. Geological and tectonic structures influence the Earth Tide measurements in a double way. Firstly the stresses in the rocks, specially at greater depths, give rise to strong drift movements which make it impossible at times to obtain any reasonable results at all. Secondly asymmetric geological features in the neighbourhood, such as faults, induce periodical residual movements.

Another interesting feature in the Earth Tide study is that, an effect of the stresses which are connected with earth tides on the occurrence of earthquakes has been claimed. It has been observed that the Gravity-Time record is greatly disturbed exactly at the same time as a seismograph is affected by an earthquake occurring at stations far removed from epicenter of the order of 6000 Km. and gradually dies down. A close examination of the gravity and seismic records obtained from neighbouring observatories with reference to particular earthquake will enable us to know the local geological structure. It appears also that the long distance earthquakes can be made use of in a similar fashion for delineating the Mohorovicic discontinuity in an area.

Gravitational attraction is in the nature of constraint, tending in accordance with general theory to shorten the period. For instance, it was calculated that for a sphere of steel of the mass and mean radius of the earth, the effect of gravity would be to lower the period from about 66 min. to about 55 min. Further, as mentioned above, the effect of gravitation is to cause an initial stress in the body in its equilibrium configuration so that the body during oscillation undergoes displacements. The renewal of interest in the oscillation problem was greatly stimulated by Benioff's discovery of an oscillatory movement of period of 57 min. in the records of the Kamchetka earthquake of 1952, which he attributed to the free oscillation of the earth. On the experimental side, this suggestion has led to the building of seismographs of very long period with the object of searching for such oscillations. The free period of earth is found to be 44' 17" and more recently it was calculated to be of the order of 53·7 min. after the Great Chillian earthquake. The search in seismograph

records for evidence of free oscillations is worth pursuing on account of the light that it may throw on the mechanism of an earthquake or large explosion. A free oscillation would not continue, if damping is present, as a result of the regular periodic vibrations in the tidal gravitation potential; when very near resonance, however, a somewhat irregularly periodic disturbance would give rise to a free oscillation, and for this reason it may be worthwhile analysing runs of gravimeter observations for traces of those free oscillations.

In the Geology Department of the Osmania University, Hyderabad, an Askania Gravimeter (GS 11) has been set up, and continuous recording of gravity-time curve has been made for the last eight months. It has been noticed that earthquakes occurring in different regions of earth's crust have considerably disturbed the normal run of the curve. The extra stress energy released due to an earthquake, together with the tide-generating force seems to have considerably increased the amplitude of the curve. In fact during recent explosions made by Russian Scientists, the disturbances caused in the normal curve are remarkable and unprecedented. The duration of the disturbance, high amplitude and intensity of the curve are of special nature and stand out prominently. No earthquake so far caused such disturbances. By comparing a month's experimental data and corresponding theoretical data, the rigidity of earth at Hyderabad has been calculated to be $4{\cdot}1 \times 10^{-11}$. Several interesting conclusions have been drawn out of this earth tide data.

Studies on Earth Tides are of recent origin and in fact not many stations in the world are recording such data. It has been noticed that practically no data are available below 20° latitude. An attempt to record the gravity-time curve and analyse it in India is bound to throw some light on understanding the underground structure, of which we know very little, and also contribute to a large extent to the world data already obtained. These studies in India are very significant because observations can be made at stations where oceanic effects can be practically eliminated. Further in a shield country like India, values of rigidity are bound to be very high and an analysis of this is interesting. When comparing the values of two different stations, attention has to be paid to factors like geographical location, influence of the ocean, i.e., the distance of the ocean surface to the observation point, meteorological influences, geological and tectonic structure and finally the elastic properties of the rocks of that area.

JOURNAL OF THE GEOLOGICAL SOCIETY OF INDIA

THE Geological Society of India was founded in Bangalore in 1958, and its formal inauguration took place at New Delhi on 23rd January 1959. The Society has as its chief object the promotion of advanced study and research in all branches of geology connected with India, and this it proposes to fulfil by, amongst other activities, (1) holding seminars and symposia on topics of current geological interest and (2) publishing a periodical (for the present annual) Journal which will bring out the outstanding work done on the Geology of India and closely related fields.

The first two volumes of this Journal have now come out under the editorship of Prof. L. Rama Rao (*Journal of the Geological Society of India*, Vol. 1, 1959, Pp. 166, Price Rs. 15; Vol. 2, 1961, Pp. 103, Price Rs. 15, Bangalore-4). The contents of the two volumes speak of the high standard of the Journal and the extent of the coverage.

Volume 1 contains 14 papers. The first is a summary of the Presidential Address on "Evolution of the Desert Belt of Asia" delivered by Dr. D. N. Wadia on the occasion of the Inauguration of the Society. In this Dr. Wadia has developed his thesis that the arid zone of Afro-Asia has arisen as a reaction from the Pleistocene Age of the northern hemisphere. Amongst the other articles in this volume are "The Great Vindhyan Basin of Northern India" by M. S. Krishnan and J. Swaminath. "The Source of the Deccan Trap Flows" by W. D. West and "Tertiary Stratigraphic Correlation in the Indo-Pacific region and Australia" by M. F. Glaessner.

Included in the 11 papers in Volume 2 are "Guiding principles in Stratigraphy" by H. G. Schenek. "Radioactivity of Some Rocktypes of Andhra State" by C. Mahadevan *et al.*, "The 'Champion Gneiss' in the Archæan Complex of Mysore" by B. Rama Rao and "Petrology of the Lavas of Pavagad Hill, Gujarat" by S. C. Chatterjee.

Many of the authors who have contributed to these two volumes are well-known geologists. The subjects covered are wide in range and the standard of the articles is high. The printing and get-up of the Journal are also of high quality. There is no doubt that the publication of the Geological Society of India will serve a keenly felt want in our country and will be welcomed not only in India but also in other countries of the world where currently rapid advances in various aspects of geological studies are taking place.

LETTERS TO THE EDITOR

POTENTIAL CONSTANTS AND THERMODYNAMIC PROPERTIES OF IF_5 AND IF_7

BRAUNE AND PINNOW[1] by the electron diffraction study concluded that the structure for IF_5 was probably a trigonal bipyramid with the point group D_{3h}. Later the electron diffraction studies by Rogers, Wahrhaftig and Schomaker[2] and Bauer[3] and nuclear magnetic resonance study by Gutowsky and Hoffman[4] confirmed the C_{4v} model for IF_5. Further the C_{4v} model is in accord with expected bond hybridization of d^2p^3 orbitals. Moreover Pauling[5] has pointed out that in atoms with an unshared pair of electrons the unshared pair tends to "occupy" one of the corners of the co-ordination polyhedron as though to replace the shared pair of the bond, and that for a central atom with five bonds and one unshared pair, the five bonds should be directed toward the five corners of a square, i.e., the structure should be C_{4v}. The study of directed valence from group theory by Kimbel,[6] Duffey[7] and Scott[8] the nuclear magnetic resonance study by Gutowsky and Hoffman[4] and the electron diffraction studies by Bauer,[3] Lavilla and Bauer[9] and Burbank[10] confirmed the pentagonal bipyramidal structure with the point group D_{5h} for IF_7. Lord and his co-workers[11] studied the Raman and infrared absorption spectra of IF_5 and IF_7 on the basis of C_{4v} and D_{5h} models respectively and the fundamental frequencies given by them are taken now for the evaluation of potential constants on the basis of Wilson's group theoretical method[12] and the calculation of thermodynamic properties.

The selection of internal co-ordinates, construction and orientation of symmetry co-ordinates and the choice of potential function for both IF_5 and IF_7 will be published elsewhere. The molecular parameters[9-11] for IF_5 are $D = d = 1{\cdot}75$ Å, $\theta = 86°\ 12'$ and $\phi = 105°$ and for IF_7 are $D = d = 1{\cdot}825$ Å, $\theta = 72°$ and $\phi = 90°$. The obtained potential constants in 10^5 dynes per cm. are as follows:— $f_D = 3{\cdot}6958$, $f_d = 3{\cdot}3243$, $f_q = 0{\cdot}4492$, $f_q' = 0{\cdot}2816$, $f_\theta = 0{\cdot}4032$, $f_\phi = 0{\cdot}2518$, $f_{dd} = 0{\cdot}6524$, $f_{\theta\theta} = 0{\cdot}1586$ and $f_{\phi\phi} = 0{\cdot}0937$ for IF_5 and $f_D = 3{\cdot}4899$, $f_d = 3{\cdot}0032$, $f_p = 0{\cdot}5013$, $f_q = 0{\cdot}3224$, $f_\theta = 0{\cdot}2519$. $f_\phi = 0{\cdot}2131$, $f_{p\theta} = 0{\cdot}2258$, $f_{dd} = 0{\cdot}5824$, $f'_{dd} = 0{\cdot}1541$, $f_{d\theta} = 0{\cdot}1387$, $f_{\theta\theta} = 0{\cdot}0825$ and $f_{\phi\phi} = -0{\cdot}0315$ for IF_7.

The heat content, free energy, entropy and heat capacity were calculated for this molecule for 15 temperatures from 100° to 1300° K. using the fundamental frequencies for IF_5. A rigid rotator, harmonic oscillator model was assumed and the values were calculated for the ideal gaseous state at one atmospheric pressure. Nuclear spins and isotopic mixing were neglected. Using the above parameters the moments of inertia for IF_5 are as follows:—

$$I_{zz} = I_{xx} = 182{\cdot}2727 \text{ AWU Å}^2$$
$$(302{\cdot}7785 \times 10^{-40} \text{ g. cm.}^2) \text{ and}$$
$$I_{yy} = 217{\cdot}322 \text{ AWU Å}^2$$
$$(360{\cdot}9999 \times 10^{-40} \text{ g. cm.}^2).$$

The symmetry number is 4. The values for the thermodynamic properties for IF_5 are given in Table I. The thermodynamic functions for IF_7 have been calculated by LaVilla and Bauer[9] by using the same fundamental frequencies used here for the calculation of potential constants and hence they need not be repeated here.

TABLE I

*Heat content, free energy, entropy and heat capacity of Iodine pentafluoride for the ideal gaseous state at one atmospheric pressure**

T (°K.)	$(H_0 - E_0°)/T$	$-(F_0 - E_0°)/T$	S°	$C_p°$
100	9·046	40·412	49·458	11·827
200	12·267	47·641	59·908	18·908
273·16	14·582	51·815	66·397	22·698
298·16	15·303	53·114	68·417	23·696
300	15·363	53·220	68·583	23·769
400	17·840	57·991	75·831	26·557
500	19·768	62·204	81·972	28·186
600	21·256	65·908	87·164	29·180
700	22·431	69·271	91·702	29·819
800	23·362	72·267	95·629	30·248
900	24·159	75·112	99·271	30·561
1000	24·806	77·661	102·467	30·786
1100	25·372	80·135	105·507	30·957
1200	25·843	82·361	108·204	31·087
1300	26·255	84·489	110·744	31·189

* T is the temperature in degrees Kelvin, the other quantities are in cal. deg.$^{-1}$ mole^{-1} and $E_0°$ is the energy of one mole of perfect gas at absolute zero temperature.

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Government of India, for the award of a Post-Graduate Research Scholarship.

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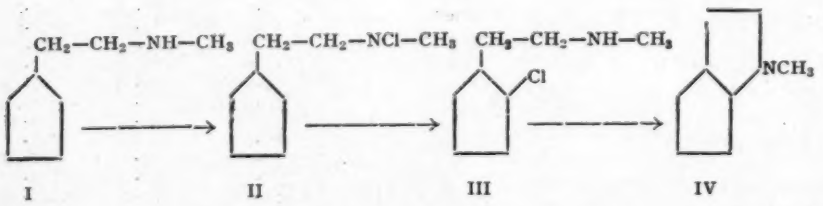
SYNTHESIS OF N-METHYL-2-AZABICYCLO (3, 3, 0) OCTANE

A METHOD for building cis-2-azabicyclo (3, 3, 0) octane ring system present in solanidane nucleus (rings D, E) has been developed. It opens up a route, starting from C_{17} carbonyl group, to synthetic azasteroids with beta C_{16}-N linkage. These bases are expected to show useful pharmacological activity but attempts to synthesise them have not been successful.[1] The method holds further promise for the total syntheses of natural solanum alkaloids.



I II III IV

Cyclopentanone was converted into ethyl cyclopentylidenecyanoacetate in 92% yield by using Cragoe's[2] modification of the Cope-Knoevenagel reaction. The cyanoacetate on hydrogenation, hydrolysis and decarboxylation furnished cyclopentylacetic acid. The corresponding acid chloride was condensed with methyl amine to obtain an 84% yield of N-methyl-cyclopentylacetamide, b.p. 148–50°/13 mm. (Found: C, 68·31; H, 10·56. $C_8H_{15}NO$ requires C, 68·52; H, 10·81%.) Reduction with lithium aluminium hydride gave N-methyl-2-cyclopentylethyl amine (I), b.p. 60–61°/8 mm. in 69% yield. Picrate crystallised from ethanol, m.p. 121–121·5°. (Found: C, 47·16; H, 5·65; N, 16·05. $C_{14}H_{20}N_4O_7$ requires C, 47·34; H, 5·59; N, 15·65%.)

The secondary amine I was treated with N-chlorosuccinimide to obtain the corresponding N-chloroamine (II) which was rearranged to the isomeric C-chloramine III, in concentrated sulphuric acid. The final ring closure to the tertiary amine IV was effected with dilute sodium hydroxide solution. Picrate of amine IV crystallised from benzene, m.p. 219–219·5° (Found: C, 47·58; H, 5·05. $C_{14}H_{18}N_4O_7$ requires C, 47·57; H, 5·05%).

The attempted rearrangement with ultraviolet irradiation gave inferior results.

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2 : 4-DINITROPHENYLHYDRAZONES OF SOME FLAVANONES

2 : 4-DINITROPHENYLHYDRAZONES as derivatives of the carbonyl in the benzo-pyrone system was first reported by Mozingo and Adkins[1] and subsequently by Douglas *et al.*[2] The work is extended to a large number of flavanones made available during the course of synthetic work in progress in these laboratories. It is now found that these condensations could be effected using alcoholic dinitrophenylhydrazine in presence of concentrated hydrochloric acid and the reaction was complete during 12-24 hours. These show a prominent absorption band between 400–410 mμ. Table I gives a summary of the results obtained during this investigation.

TABLE I

2 : 4-Dinitrophenylhydrazone of	Melting point	Appearance	Analysis for Nitrogen		
			Formula	Calculated	Found
7-Hydroxy-flavanone ..	270–71	Deep orange red needles (E.A.)	$C_{21}H_{16}O_6N_4$	13·3	12·9
7-Methoxy-flavanone ..	259–60	Scarlet red plates (E.A.)	$C_{22}H_{18}O_6N_4$	12·9	13·0
7-Hydroxy-6-ethyl flavanone ..	258	Orange red needles (Alc.)	$C_{23}H_{20}O_6N_4$	12·5	12·4
7-Hydroxy-4'-methoxy-flavanone ..	223–24	Deep red plates (Alc.)	$C_{22}H_{18}O_7N_4$	12·4	12·5
6-Hydroxy-flavanone ..	280	Orange red needles (E.A.-Alc.)	$C_{21}H_{16}O_6N_4$	13·3	12·9
5-Methoxy-flavanone ..	250	Crimson red rectangular plates (E.A.)	$C_{22}H_{18}O_6N_4$	12·9	12·7
5 : 7-Dihydroxy-flavanone ..	266–68	Bright red rectangular plates (E.A.-Alc.)	$C_{21}H_{16}O_7N_4$	12·8	12·5
5 : 7-Dimethoxy flavanone ..	231–32	Scarlet red rectangular plates (E.A.)	$C_{23}H_{20}O_7N_4$	12·1	11·8
5-Hydroxy-7-methoxy-flavanone ..	236–38	Deep red rectangular plates (E.A.)	$C_{22}H_{18}O_7N_4$	12·4	12·3
5-Hydroxy-7-benzyloxy-flavanone	217–18	do.	$C_{28}H_{22}O_7N_4$	10·6	10·8
5-Methoxy-7-benzyloxy-flavanone	215–16	Bright red needles (E.A.)	$C_{29}H_{24}O_7N_4$	10·4	10·6
6-Hydroxy-7-methoxy-flavanone ..	286	Deep red rectangular prisms (E.A.)	$C_{22}H_{18}O_7N_4$	12·4	12·4
7 : 8-Dihydroxy-flavanone ..	258	Deep red rectangular plates with a green reflex (E.A.)	$C_{21}H_{16}O_7N_4$	12·8	12·5
7 : 8-Dimethoxy-flavanone ..	247	Orange red rectangular plates (E.A.)	$C_{23}H_{20}O_7N_4$	12·1	12·4

E.A.: Ethyl acetate. Alc.: Ethyl alcohol.

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SYNTHESIS OF THIOUREIDO-TRIPHENYLMETHANES

MANY aryl isothiocyanates and thioureas are known to possess bactericidal and antitubercular activity.[1] It was of interest to prepare thioureas containing triphenylmethyl substituent and study its modifying effect on -N-CS-N- group which is primarily responsible for the activity.

Triphenylmethyl isothiocyanate was prepared according to Ilicito *et al.*[2] in 90% yield. This was then condensed with different amines according to the method described by Trivedi *et al.*[3]

Table I indicates the compounds thus prepared with necessary modifications. All thioureas were crystallised from petrol ether (60–80°) in colourless needles or platelets. All melting points are uncorrected.

Authors thank Dr. N. M. Shah for interest and the Principal for facilities.

TABLE I

$Ph = C_6H_5$ - Ph_3 $-C-NH-CS-NH-$ R

No.	R =	Formula	M.P. °C.	Analysis % S	
				Found	Required
1	C_6H_5	$C_{26}H_{22}N_2S$	82	8·0	8·1
2	*p*-$C_6H_4CH_3$	$C_{27}H_{24}N_2S$	156–58	7·8	7·8
3	*p*-$C_6H_4OCH_3$	$C_{27}H_{24}N_2SO$	152–53	7·4	7·5
4	*o*-$C_6H_4OCH_3$	$C_{27}H_{24}N_2SO$	162	7·0	7·5
5	*a*-$C_{10}H_7$	$C_{30}H_{24}N_2S$	80[c]	7·1	7·2
6	B-$C_{10}H_7$	$C_{30}H_{24}N_2S$	157–58	7·4	7·2
7	*p*-C_6H_4SCN	$C_{27}H_{21}N_3S_2$	80	14·1	14·2
8	*p*-$C_6H_4N(CH_3)_2$	$C_{28}H_{27}N_3S$	80[b]	7·1	7·3
9	C_6H_5NH-	$C_{26}H_{23}N_3S$	130[c]	7·6	7·8
10	$-CH_2COOH$	$C_{22}H_{20}N_2O_2S$	130[d]	8·3	8·5
11	6-$C_9H_5O_2$ (Coumaryl)	$C_{30}H_{22}N_2OS$	76–77	6·9	7·0
12	Diphenylamine	$C_{32}H_{26}N_2S$	130[e]	6·6	6·8

[a] Difficulty involved; required three hour reflux and repeated crystallisation.
[b] Difficulty involved; required three hour reflux and repeated crystallisation.
[c] Mixed melting point with isothiocyanate (138°) depressed to 80°.
[d] Mixed melting point with isothiocyanate (138°) depressed to below 100°.
[e] Mixed melting point with isothiocyanate (138°) depressed to 110°.

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Ahmedabad-9, *July* 17, 1961.

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EFFECT OF GAMMEXANE ON FLAVOPROTEIN ENZYMES OF RAT LIVER

GAMMEXANE, the gamma isomer of hexachloro cyclohexane is toxic to rats at a dosage of 40-80 mg.% in the diet. (Doisy and Bocklage, 1949). Liver damage is the most prominent pathological feature in animals and human subjects poisoned with gammexane (Report to the Council on Pharmacy and Chemistry, 1951).

Xanthine oxidase and D-amino-acid oxidase are two of the important flavoprotein enzymes present in rat liver. The activity of these flavoprotein enzymes may get affected in a diseased liver brought about by gammexane intoxication. The scope of the work was therefore to study xanthine oxidase and D-amino-acid oxidase activities of rat liver when the rats were fed a diet containing gammexane in toxic amounts.

Xanthine oxidase activity in the liver of rats was estimated by the method of Litwack *et al.*, 1953. D-amino-acid oxidase activity of rat liver was estimated by Warburg's manometric method (Umbriet *et al.*, 1957) as done by Decker and Byerrum (1954).

Albino rats weighing 70 ± 10 gm. were grouped into two groups of 8 rats each. Group 1 rats which were the controls had the basal diet which contained 21% casein (devitaminised by repeated washing with rectified spirit), 65% sucrose, 7% arachis oil, 4% salt mixture (Dalgliesh, 1952), 1% vitamin mixture (Burch *et al.*, 1956) without inositol but with 30 mg.% of riboflavin and 2% codliver oil. Group 2 rats received the basal diet with 80 mg.% of gammexane (Doisy and Bocklage, 1949). Animals were kept on the experimental diet for 6 weeks at the end of which they were sacrificed for enzyme estimation.

Rats which received gammexane had very poor growth rate. They exhibited hypersensitivity and hyperirritability. The xanthine oxidase activity of the liver of rats receiving gammexane was inhibited to the extent of 55%. (The average xanthine oxidase activity of the liver of rats on basal diet and 80 mg.% gammexane was $3{\cdot}17 \pm 0{\cdot}23\,\mu$ Moles of xanthine oxidised per hour per gm. of wet liver whereas that of control rats was $7{\cdot}1 \pm 0{\cdot}21\,\mu$ Moles.) Inhibition of xanthine oxidase activity by gammexane has not so far been reported though it has been shown that folic acid (Prema Fatterpaker and Srinivasan, 1951), (Williams, Jr., J. N., 1950), Vitamin C (Feigelson Philip, 1952), Isatin, Ninhydrin and alloxan (Bruns, 1954), inhibit xanthine oxidase activity.

The liver D-amino-acid oxidase activity of rats was not affected by gammexane intoxication.

As xanthine oxidase is a riboflavin-containing enzyme and as its activity was inhibited by gammexane, increased amounts of riboflavin (600 μg.%) along with gammexane were given to rats for 4 weeks to find out whether increased concentration of dietary riboflavin will offset the inhibition. It was found that doubling the amount of dietary riboflavin did not correct the inhibition.

As gammexane is an antimetabolite of inositol, (Sarma, 1950; Rajalakshmi *et al.*, 1960) it was tried whether addition of inositol to the diet will reverse the inhibition of xanthine oxidase activity by gammexane. 400 mg.% of inositol given with 80 mg.% gammexane in the diet for a period of 4 weeks did not reverse the inhibition.

Summary.—Gammexane added to the diet in a concentration of 80 mg.% inhibits liver xanthine oxidase activity of rats to the extent of 55%. This inhibition is not reversed by increased amounts of dietary riboflavin or inositol and appears to be due to direct poisoning of the enzyme. Liver D-amino-acid oxidase activity is not affected in gammexane intoxication. The two flavoprotein enzymes behave differently towards gammexane.

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INFLUENCE OF HOST PLANTS ON THE AMINO-ACID MAKE-UP OF *SANTALUM ALBUM* LINN.

ALTHOUGH *Santalum album* Linn. has long been recognised as an obligate root parasite,[1-3] the nature and degree of its dependence upon its host plant has not been precisely and fully elucidated. Venkata Rao's[4] observation that the leaves of sandal plants growing in forest areas in close proximity to strychnos plants, tasted characteristically bitter, suggested that the sandal might be drawing from its host fully or partially elaborated sap constituents. Later[5] sandal plants grown in big 40 gallon steel drums with strychnos and melia plants exclusively as the respective host plants, showed that in both cases the bitter principles had been transferred to the sandal leaf. The absolute identity of the bitter principles derived from the leaves of sandal and from the host, has not, however, been established.

The present communication deals with a chromatographic study of the amino-acid make-up of the 12-month-old sandal plants raised in the nursery in pots in association with different host plants, *Acacia farnesiana*, *Sesbania grandiflora*, *Pongamia glabra*, tomato and *Lantana camara*; leaves from sandal plants growing slowly *without* any host plant, and also leaves from the respective host plants, have been studied.

Leaf material consisting of the third leaf from the growing tip, was collected from the nursery and immediately ground up and extracted with 70% v/v ethanol acidified with acetic acid. The brei was centrifuged at 3,000 RPM for 30 minutes and the clear supernatant, 10 µl., was streaked on rectangular strips of Whatman No. 1 filter-paper 570 × 165 mm. Chromatograms were developed by the downward flow of the solvent mixture composed of butanol, acetic acid-water 4 : 1 : 5, at room temperature, 24–26° C. The runs were completed usually in about 30 hours. After air-drying, the chromatograms were sprayed with 0·1% ninhydrin in butanol and dried in an oven for 10 minutes.

A careful reading of the chromatograms revealed that the leaves from sandal plants, *without* any host plant, had practically no basic amino-acids although they had a heavy concentration of oxyproline. Leaves from sandals, growing in association with leguminous plants which are good hosts, showed high concentrations of the basic amino-acids. Leaves from sandals nourished by non-leguminous hosts which are poor, like tomato and lantana, had only a relatively low proportion of the basic amino-acids. In fact, the rate of growth of sandal plants appeared to be roughly related to the concentration of the amino-acids furnished by the host plants. Sandal *without* a host plant lacks the mechanism to synthesise the basic amino-acids, which are intimately connected with the genetic material make-up and function of all organisms. The sandal is dependent upon its host plant for the supply of these basic amino-acids.

The chromatograms also show that the sandal plant is capable of synthesising oxyproline in appreciable quantities *without* any host plant. Most of the host plants, so far investigated, have not revealed the presence of any oxyproline in their leaves although proline is definitely present.

Further work on the quantitative aspects of the problem is in progress. Our thanks are due to Dr. P. S. Rao and Dr. M. N. Ramaswamy, for their kind interest.

Forest Res. Lab., Malleswaram, Bangalore-3, *November* 14, 1961.
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REVERSIONS IN DRUG RESISTANCE OF *VIBRIO CHOLERAE*

INCIDENCE of bacterial resistance to drugs has been well established by a number of workers in recent years. The bacterial geneticists tend to believe the theory of spontaneous mutation and selection rather than a direct induction of resistance due to the effects of drugs. The two ideas have later been complemented[1] on the basis of differential selection due to differential inhibition and Lamarckian inheritance of resistance[2] in bacteria has been widely accepted. In a detailed study to evaluate the chemotherapeutic importance of chloramphenicol against *Vibrio cholerae* which is being worked out in this department, it was found necessary to investigate into the stability of resistant forms of *V. cholerae* emerging out of the effect of the drug. The present experiment, worked out with 200 µg./ml. chloramphenicol resistant *V. cholerae*,

obtained through 'single step' and 'multiple step' treatments, showed varying degrees of reversions in resistant *V. choleræ*.

The culture used in this experiment was a typically flagellated strain of *V. choleræ*, isolated from a human carrier and obtained from the School of Tropical Medicine, Calcutta. It was found to be sensitive to chloramphenicol (2 μg./ml.) *in vitro*. Resistance in *V. choleræ* to 200 μg./ml. of chloramphenicol was induced in a 'single step' and in 'multiple steps'. 'Single step' resistance was induced by keeping the organism in contact with the drug (200 μg./ml.) for 72 hours in absence of bacterial multiplication by suspending the cells in phosphate buffer at pH 7·0. 'Multiple step' resistance was induced through serial transfers in nutrient broth with higher amounts of antibiotic. Five successive generations of the two resistant varieties obtained from the two sources were examined for stability and reversions and the mean of counts from five generations has been graphically represented. Survival was counted by turbidimetry after an incubation of 4 hours at 37° C.

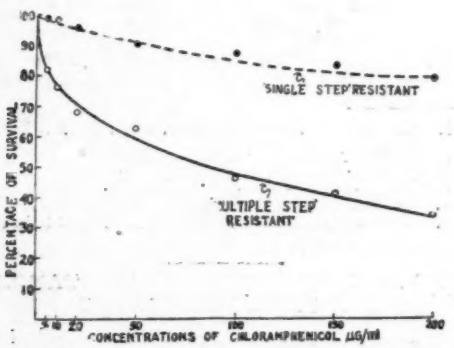

FIG. 1. Percentage survival of resistant (200 μg./ml.) *Vibrio choleræ* indicating reversions at different concentrations of chloramphenicol. The data represent a mean of five generations.

From the data it is observed that the rate of reversibility is more rapid in 'multiple step' resistant forms than those induced in a 'single step' where the mutant is more stable. If the theory of spontaneous mutation and subsequent selection is accepted, the drug must have acted on different loci at different concentrations, thus involving different genes in developing resistance. But the mechanism seems to be somewhat similar in both cases, since the nature of the two reversion curves follows the same tendency. Higher stability in 'single step' resistant forms may only be explained in terms of mutation of some additional genes which remained stable and lost the power of back mutation in them.

In the light of our present knowledge of reversions in induced mutants[3,4] where mutation frequency in measurements of reversions varied widely (which in some instances reached as high as 80%), many different mutations of uncertain genetic status were observed as compared to the more restricted assay when using reversions under conditions of controlled genetics. In drug resistance also it is possible that mutations of uncertain genetic status are evolved which may explain the difference in the shape of mutation-reversion curves, as observed in this case.

Department of Microbiology, P. M. NAHA.*
Bose Institute,
Calcutta-9, *June* 10, 1961.

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AN IMPROVED BASAL MEDIUM FOR THE MICROBIOLOGICAL ASSAY OF RIBOFLAVIN USING *LACTOBACILLUS CASEII*

WHILE assaying samples of potatoes for riboflavin using the medium of Snell and Strong (1939), it was observed that the unknowns consistently produced dose-response curves with much steeper slopes than those for the standards and this necessitated a re-examination of the medium to determine whether it was "complete" for the test organism, *L. caseii*. Earlier modifications in the composition of this medium (Greene and Black, 1943; *Pharmacopeia of the U.S.A.*, XII, 1943; Roberts and Snell, 1946; Clarke, 1953) have not proved very successful in extending the range of linearity in the dose-response curve beyond 0·0–0·2 μg. dose levels of riboflavin, although the sensitivity of the assay was markedly improved.

The nutritional requirements of *L. caseii*, as understood at present (Snell, 1945), is much more complex than those for the other species of the genus. Recent work on the improvements of the medium has taken cognisance of the essential, rather than the stimulatory nature of some of the members of the group of B vitamins, other than riboflavin. Assays with trial media

proved that for the maximum elongation of the linear portion of the dose-response curve, supplementary doses of calcium pantothenate, p-aminobenzoic acid, pyridoxine hydrochloride, biotin and folic acid, in addition to an increase in the concentration of glucose and yeast extract solution, three-fold and five-fold respectively, as in the Snell and Strong medium, were essential. The final medium adopted had the following composition :—

TABLE I

Composition of the improved basal medium

Constituents		Amount per 100 ml. double strength medium
Alkali-treated, photolysed peptone (DIFCO) gm.		1·0
Yeast extract (OXO), lead-acetate-treated, gm.		1·0
Glucose, anhydrous, gm.	..	6·0
Sodium acetate, gm.	..	1·2
Cystine, mg.	..	100
Inorganic salts, mg.	..	
Salts A :		
KH_2PO_4	..	100
K_2HPO_4	..	100
Salts B :	..	
$MgSO_4$, 7 H_2O	..	40
$MnSO_4$, 4 H_2O	..	2
$FeSO_4$, 7 H_2O	..	2
NaCl	..	2
Vitamin supplements, µg.		
Calcium pantothenate	..	20
p-aminobenzoic acid	..	20
Pyridoxine hydrochloride	..	20
Biotin	..	0·08
Folic acid	..	0·016

The peptone and yeast extract solutions were prepared by the procedure of Snell and Strong (1939), with this slight modification that light exposure period for the alkali-treated peptone solution was extended to 36 hours to eliminate riboflavin completely. The vitamin supplements were dispensed from a stock solution in 25% ethyl alcohol.

The comparative performance of this medium with those of Roberts and Snell, Greene-Black, and modified U.S.P. (Clarke, 1953) was studied and tests for the precision of the assay worked out. The assay procedure was essentially the same as that of Snell and Strong as modified by collaborative study (Snell, 1950).

The stock culture was *L. caseii*, ATCC 7469. Stab transfers were made weekly in glucose-agar-yeast extract (Pennington *et al.*, 1940), but were passed through an enrichment medium containing fresh liver extract as recommended by Nymon and Gortner (1946), once a month to maintain the vigour of the culture.

The dose-response curves obtained with the four media are presented in Fig. 1. The statisti-

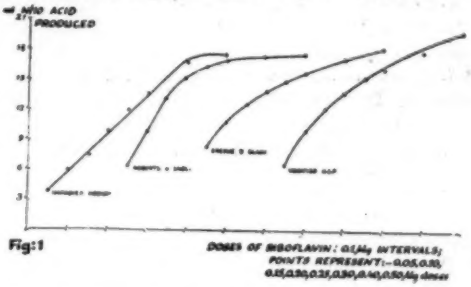

Fig:1

cal data for the evaluation of the response curves are given in Table II.

TABLE II

Evaluation of response curves

	Improved medium	Roberts & Snell	Modified U.S.P.	Greene-Black
Approximate range of linearity, µg.	0·05–0·40	0·05–0·20	0·10–0·25	0·10–0·20
Maximum N/10 acid produced, ml.	17·4	17·3	19·9	18·3
Variance for difference btween duplicates, sampling error, s^2	0·081	0·098	0·103	0·094
Slope of curve, b	38·46	41·02	36·20	33·00
Expected precision of bioassay employing linear portion of curve, $s/b=\lambda$	0·0074	0·0077	0·0089	0·0091

The data show that the improved medium is superior to the others tested, for the following reasons : (i) the blank titre value is very low ; (ii) the value of λ is the lowest, which gives it the greatest precision, and (iii) the range of the linear portion of the dose response curve is the longest, *i.e.*, 0–0·4 µg. riboflavin.

The author wishes to place on record his grateful thanks to Dr. Pushkarnath, Director, Central Potato Research Institute, for the facilities provided and to Dr. V. S. Krishnamachar of the National Chemical Laboratories, Poona, for supplying the type culture of the organism and for helpful guidance.

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A PRELIMINARY NOTE ON THE CHEMICAL AND PHARMACOLOGICAL EXAMINATION OF *STREBLUS ASPER* LOUR.*

Streblus asper Lour. is a small tree indigenous to tropical India. It belongs to the family Urticaceæ. The decoction of its bark is given in fever, dysentery and diarrhoea, while the root is described to possess antiseptic and astringent properties.[1] However, it was brought to our notice that the decoction of the leaves of this plant is prescribed in the treatment of high blood pressure, and also for easy painless quick delivery during labour.

In the course of the routine pharmacological screening of the leaves and roots of the plant, the total alcoholic extract particularly of the root bark was found to indicate interesting activity on blood pressure, isolated frog heart, isolated rabbit intestine and guinea-pig uterus. It was therefore taken up for detailed investigation.

The dried root-bark, after initial treatment with petrol, was extracted with 90% alcohol at room temperature. The extract was concentrated under reduced pressure, and then freed from the chlorophyllous and other inactive impurities. It showed the presence of glycosides, free sugars, tannins and KCl; tests for alkaloids were negative. The clear filtrate was then extracted with chloroform, which yielded the active principle in the form of a creamish-yellow coloured powder. It was extremely bitter to taste and was highly hygroscopic. It was purified by taking in water and re-extracting the clarified water solution with chloroform. It was finally obtained in the form of beautiful white rosettes crystallised from sulphuric ether in a dry atmosphere. It melts at 160° C. It has a molecular formula $C_{19}H_{28}O_6$; contains one OCH_3 and one CCH_3 group, and 2 or 3 'active hydrogen'. It is soluble in most of the solvents, except petrol; it is more soluble in water and chloroform. With acetic anhydride and conc. H_2SO_4 it gives a play of colours, colourless—pink—green; it decolourises $KMnO_4$ and Br_2-water; it reduces Tollen's reagent slowly. It was found to be an $\alpha\beta$-unsaturated lactone.

When examined pharmacologically, this lactonic substance showed interesting activity of a marked degree. Administered by the intravenous route the LD/50 in white mice (average weight 18–21 gm.) is about 4·8 mg./Kg. Initial symptoms of acute clonic convulsions followed by a short period of lethargy are the principal toxic manifestations. In urethan anæsthetized rabbits doses between 5×10^{-8} and 5×10^{-7} induce prolonged hypotensive response preceded by an acute pressor effect, associated with an enhanced respiratory rate, the higher 5×10^{-7} dose being lethal. Studied on isolated frog heart (*R. tigrina*) it induces a positive inotropic effect in 10^{-5} dilution and a systolic response in 10^{-4} dilution. The *in vitro* spasmodic effect of the compound as judged on the smooth musculature of the rabbit intestine and guinea-pig (virgin) uterus is pronounced in that high dilutions between 5×10^{-8} and 5×10^{-7} produce tonic contractions, reversible on washing.

This pronounced action on the smooth musculature including the cardioactivity shows the possibility of the substance being developed into a drug.

Scientific Department, CIBA of India Limited, Bombay-1, *October* 3, 1961. F. FERNANDES. V. N. KAMAT. S. S. BHATNAGAR.**

* This work was carried out during the period September 1955–May 1956.

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DEVELOPMENT AND VIABILITY OF EGGS PRODUCED IN *CORCYRA CEPHALONICA* STAINT. FOLLOWING ADMINISTRATION OF ANTIBIOTICS

SEVERAL reports[1–3] have appeared where feeding antibiotics to animals including insects had, on some occasions, stimulated growth but on others remained ineffective or even deleterious to them. The present communication deals with the measurement of the effect of dietary penicillin, oleandomycin and terramycin on growth and hatchability of eggs in *Corcyra cephalonica* Staint.

Single pair bred culture of *Corcyra* was employed in this experiment. The culture was successfully raised on crushed *'juar'* (*Sorghum vulgare*) in 8" × 6" jars at temperatures ranging between 85° F. and 95° F. For experimental purposes 10" × 2" glass vials were filled with 120 g.

of crushed *'juar'*. Weighed quantities of the antibiotics, penicillin, oleandomycin and terramycin were incorporated in the diet by thoroughly distributing the premix in the vials containing the food. Premix was prepared in glucose in convenient amounts for efficient mixing. The control groups received an equal amount of glucose only in diet. Twenty-five freshly laid eggs (24 hours' layings) were introduced in the experimental vials containing different levels of the various antibiotics. Four replications were used for each treatment. For comparison of the overall development, growth index[4] was calculated. The index was obtained by dividing the percentage of moths that emerged (N) by the average time taken to complete development (Av). The greater the value of the index, the better was the development of the insect.

Moths emerging from the different treatments were paired within the same lot. Single pairs were confined in glass vials 8" × 2" for egg laying. These vials contained thirty small pieces of black paper rolled in balls of the size of *'juar'* seed. No food was supplied to the moths. Twenty-five eggs from each of the four replications were taken out at random making a total of hundred eggs from a particular treatment. The lots of hundred eggs each from all treatments were kept separately for incubation in 10" × 2" glass vials with some quantity of crushed *'juar'*. The data on hatchability and development were regularly recorded. The results of study are presented in Tables I and II.

It is evident from Table I that penicillin effected more successful emergence of this insect at the levels of application from the 50 p.p.m. to 500 p.p.m. At 1,000 p.p.m. level the growth was retarded. Oleandomycin gradually suppressed growth with the increasing rate of application. Terramycin enhanced the growth of this insect at all levels of application. The increased growth response, however, gradually slowed down with the higher doses of the intake of this antibiotic. Data summarized in Table II reveal that penicillin reduced the viability of eggs at 500 p.p.m. and 1,000 p.p.m. levels. Oleandomycin increased the viability at 500 p.p.m. level but reduced it at 1,000 p.p.m. level. Terramycin did not produce any effect on the viability of eggs.

TABLE II

Effect of antibiotics on the viability of eggs of Corcyra cephalonica

Supplement p.p.m.	Penicillin Viable eggs %	Oleandomycin Viable eggs %	Terramycin Viable eggs %
50	57	62	84
100	57	64	81
500	54	78	79
1,000	51	51	78
Control	66	65	80
95 % C. I. Limit	56 to 75	55 to 74	71 to 87

Grateful thanks are due to Dr. B. K. Srivastava, Entomologist to the Government of Rajasthan, Jobner, for guidance and to Principal V. V. John for providing necessary facilities and encouragement. Gift of the antibiotics through M/s. Dumex Private Ltd., Bombay, is thankfully acknowledged.

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TABLE I

Effect of antibiotics on the development of Corcyra cephalonica

Lot No.	Supplement p.p.m.	Penicillin Adult emergence (N) %	Penicillin Average time taken for complete development in days Range	Penicillin Average time taken for complete development in days Average (Av.)	Penicillin Growth Index N/Av.	Oleandomycin Adult emergence (N) %	Oleandomycin Average time taken for complete development in days Range	Oleandomycin Average time taken for complete development in days Average (Av.)	Oleandomycin Growth Index N/Av.	Terramycin Adult Emergence (N) %	Terramycin Average time taken for complete development in days Range	Terramycin Average time taken for complete development in days Average (Av.)	Terramycin Growth Index N/Av.
1	50	40	33–54	38·45	1·04	36	41–58	41·71	0·87	65	35–51	42·19	1·54
2	100	56	33–48	38·46	0·68	27	40–51	43·52	0·62	61	36–66	41·39	1·47
3	500	34	33–46	37·70	0·90	18	40–66	44·89	0·4	54	35–55	42·17	1·28
4	1,000	22	34–41	37·45	0·59	18	41–57	46·00	0·39	50	37–55	42·38	1·18
5	Control	26	33–48	38·61	0·67	39	41–54	44·59	0·88	45	35–66	41·33	1·09

METACHROMASIA OF EARTHWORM EGGS

KELLY[1,2] has studied metachromasia in several animals from annelids, molluscs, echinoderms, arthropods and some chordates. As most of the animals selected by him are marine, it is felt that a study of metachromasia in the eggs of freshwater and land animals, will be of interest, and the present note contains a report on the metachromasia of the eggs of the earthworm, *Pheretima elongata* (Perrier).

Ovaries of the earthworm were used for this study. The living material was observed when vitally stained. Some of the material was fixed for the preparation of permanent slides. Kahle's fluid, 4% formalin, acetic alcohol (3 : 1) and alcohol were used for the preparation of squashes and sections, though the first was found to be the most suitable. Toluidin blue (B.D.H.) was used for vital staining and for staining of fixed material. Solutions of the dye in saline were used for vital staining, the dye concentration being 0·3 mg. per 100 ml. Fixed material was routinely stained with 0·3% toluidine blue. Only a very small amount of metachromasia was lost during alcohol dehydration. Stained material was studied by sunlight and unfiltered tungsten light.

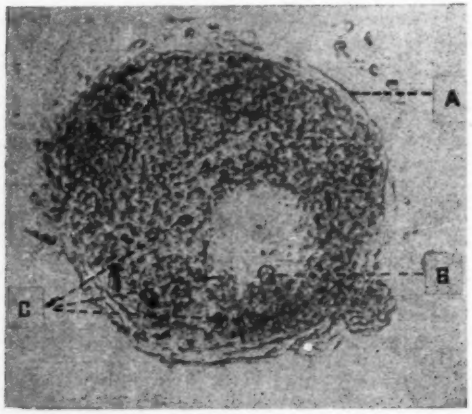

FIG. 1. Earthworm egg to show metachromasia. Vital staining by toluidine blue (0·3 mg. % in saline) jelly layer (A), nucleolus (B) and small homogeneous granules are matachromatic (pink) and ringed granules (C) are orthochromatic (blue). × 290.

The study of the fully developed eggs of the earthworm after being vitally stained by toluidine blue revealed several features (Fig. 1). Two types of rounded bodies could be made out in the cytoplasm—one was smaller, appeared homogeneous and was stained metachromatically (a beautiful pink) by toluidine blue ; the other was larger, gave a ringed appearance and was stained orthochromatically (blue). Mitochondria could be seen as continuously moving granules which were not stained, so also the vacuoles. No nuclear metachromasia was demonstrated as particularly observed in sectioned material except for a week pink colour developed occasionally in the nucleolus. When the fixed material was stained with concentrated (0·3%) toluidine blue, the whole egg was stained an intense purple colour. This colour was to a large extent stable to alcohol dehydration. Jelly layer covering the egg was also lightly metachromatic.

From the study of photomicrographs, published by Kelly[1,2] of the eggs of different marine annelids, it seems that the earthworm egg, in the present investigation, is more intensely metachromatic, particularly the bodies mentioned above. The small and homogeneously metachromatic bodies seem to correspond to L_1 bodies of Nath *et al.*[3] On the other hand the other type of bodies which are larger, vesicular and stained blue orthochromatically appear to be similar to L_2 bodies described by Nath *et al.*

In the work cited above, Nath *et al.* have applied PAS (Periodic Acid Schiff) test to the eggs of the earthworm, *Pheretima posthuma*, and on the basis of negative results claim that there are no mucopolysaccharides present in their L_1 and L_2 bodies. This test was repeated in the case of the earthworm under study (*i.e.*, *Pheretima elongata*) with similar results. On the other hand the development of metachromatic colour in the smaller homogeneous bodies (L_1 bodies of Nath *et al.* ?) indicates the presence of mucopolysaccharides. These contrary results could be reconciled only if one were to note that while the mucopolysaccharides in general are metachromatic to toluidine blue and are PAS positive, one of them, according to Jorpes *et al.*,[4] is metachromatic but PAS negative, *viz.*, fully substituted (sulphated) heparin. Thus the presence of heparin or heparin-like substances is indicated in the strongly metachromatic smaller homogeneous bodies while the occasionally visible weaker metachromasia of nucleolus is due to nucleic acid (RNA). This finding is also supported by Kelly.[1,2]

The presence of easily demonstrable heparin or heparin-like substances in the earthworm eggs is significant because according to colloid chemical theory of Heilbrunn[5] heparin has an

inhibitory effect on cell division in the eggs of lower animals.

One of us (D. N. K.) thanks the Ministry of Scientific Research, Government of India, for a grant-in-aid.

Department of Zoology, P. V. Joshi.
N. Wadia College, Poona-1, D. N. Kamat.
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STEMPHYLIUM AND *PSEUDOSTEMPHYLIUM*

Our present knowledge of the phæodictyous Hyphomycete genus *Stemphylium* Wallr. is due to Wiltshire.[1] This genus is based on *S. botryosum* Wallr.[2] In *S. botryosum*, as described by Wiltshire from type material, the spores are oval or somewhat angular, phæodictyous without a beak, often constricted at the median transverse septum and produced singly and acrogenously on the conidiophore which is typically swollen at the tip. It was stressed that the conidiophore grew through the conidial scar and produced a second conidium and that this process was repeated. Wiltshire discussed the position of *Stemphylium* as used by Harz, Oudemans, Bolle and others and indicated that in "*Stemphylium*" of these authors the spores were phæodictyous and acrogenous but were produced at the tip of the conidiophore and its successive growing points which arise sympodially but not by growth through conidial scars as in *S. botryosum*. Accordingly, Wiltshire[1] classified these species showing typical sympodial growth of the conidiophore in a subgenus *Pseudostemphylium*; species similar to *Stemphylium botryosum* were classified in the subgenus *Eu-Stemphylium*. A typical geniculate conidiophore with scars is characteristic of *Pseudostemphylium*. It is now recognized that the method of spore formation is important in the taxonomy of Hyphomycetes and therefore the subgenus *Pseudostemphylium* Wiltshire is here raised to generic rank:

Pseudostemphylium (Wiltshire) Subramanian gen. nov.

= Subgenus *Pseudostemphylium* Wiltshire, *Trans. Brit. mycol. Soc.*, 1938, **21**, 223.

Pertinet ad Fungos Imperfectos, ad Hyphomycetes, Phæodictyas. Mycelium hyalinum vel fuscum, constans e hyphis septatis, ramosis. Conidiophori fusci, surgentes ut ramuli ex hyphis vegetativis, simplices, nonnumquam furcati, septati, apicibus haud distincte tumescentibus ut in *Stemphylio*. Conidia formæ variabilis, ut plurimum ovata, haud rostrata, phæodictya, vulgo non constricta ad septum maius medium, singula vel botryose fasciculata insidentia conidiophoris, acrogena, lateraliter translata ob renovationem incrementi conidiophororum ex puncto sub ipsa cicatrice conidii delapsi et ob formationem successivam conidiorum acrogenam e novis incrementi punctis; conidiophoris raro crescentibus per cicatricem delapsi conidii.

Fungus imperfectus, Hyphomycete, phæodictyæ. Mycelium hyaline to dark coloured, composed of septate, branched hyphæ. Conidiophores dark coloured, arising as branches from vegetative hyphæ, simple, sometimes branched, septate, with tips not markedly swollen as in *Stemphylium*. Conidia variable in shape, mostly ovate, not beaked, phæodictyous, usually without constriction at major median septum, borne singly or in botryose clusters on conidiophores, acrogenous, displaced laterally due to renewed growth of conidiophore from a point below scar of fallen conidium and formation of successive conidia acrogenously from the new growing points; conidiophore seldom growing out through scar of fallen conidium.

Species Typica

Pseudostemphylium lanuginosum (Harz) Subramanian comb. nov.

= *Stemphylium lanuginosum* Harz, *Bull. Soc. imper. Moscou*, 1871, **44** (1), 132, pl. 3, fig. 1.

= "*Mystrosporium lanuginosum* Harz", *lapsus calami* in Saccardo, *Sylloge Fungorum*, 1886, **4**, 546.

Other Species

Pseudostemphylium consortiale (v. Thuemen) Subramanian comb. nov.

= *Macrosporium consortiale* v. Thuemen, 1876, *Herb. myc. oecon.* No. 450.

Pseudostemphylium radicinum (Meier, Drechsler & Eddy) Subramanian comb. nov.

= *Alternaria radicina* Meier, Drechsler & Eddy, *Phytopathology*, 1922, 12, 157-66.

= *Thyrospora radicina* (Meier, Drechsler & Eddy) Neerg., *Bot. Tidsskr.*, 1938, **44**, 359-62.

= *Stemphylium radicinum* (Meier, Drechsler & Eddy) Neerg., *Aarbertn. fra J. E. Ohlsens Enkes Plantepat. Lab.* 1939, 1 April 1938-31 March 1939, pp. 16.

Pseudostemphylium consortiale and *P. radicinum* are known from India.

I am grateful to the Rev. Fr. Dr. H. Santapau for the Latin translation of the diagnosis of the new genus.

Dept. of Botany, C. V. SUBRAMANIAN.
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NOTULAE EMBRYOLOGICAE

I. The Functions of Endosperm in *Avicennia officinalis*

THE endosperm of seed plants is described generally as the nutritive tissue of the embryo.[1] Considering variations in the behaviour of endosperm among angiosperms, much remains to be said. The exact role played by this tissue towards the nutrition of the embryo varies from species to species. It is well known that in exalbuminous seeds the developing embryo dissolves most of the endosperm. On the contrary, albuminous seeds possess a considerable mass of this tissue which is utilized by the embryo at the time of germination. However, the situation in a viviparous mangrove is exceptional regarding the development, functions and final fate of the endosperm.

In the early development of endosperm of *Avicennia*[3] it has been noticed that the endosperm tissue grows out of the ovule and lies free in the loculus. The embryo is carried out of the ovule along with the developing endosperm. At a later stage the embryo frees itself from the surrounding endosperm and comes to lie free in the loculus. However, a contact is established between the embryo and endosperm through the massive suspensor[2] (Fig. 1). The most important consideration here relates to the absence of reserves in the endosperm at any stage of development. Furthermore, it has been observed that the endosperm cells function as conductive structures facilitating the transport of nutrients from the aggressive endosperm haustorium to the suspensor. Consequently certain endosperm cells situated between the tip of the haustorium and the suspensor elongate considerably and therefore appear to be better suited for conduction. Such an internal differentiation in the endosperm tissue is probably caused by a localised diffusion of hormones from the developing embryo.

Presumably very large amounts of nutrients pass from the placental tissues to the embryo through the haustorium, endosperm and the suspensor. That it is so is evidenced by the fact that the embryo develops into a seedling before being detached from the parent tree. The phenomenon of vivipary involves continuous development of the zygote into a seedling without a period of rest. The visible expressions

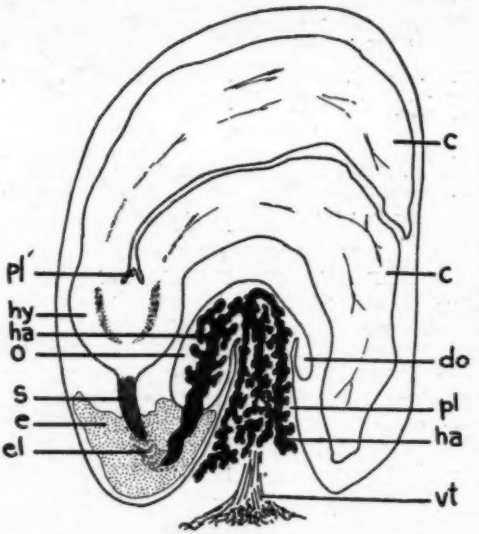

FIG. 1. L.S. of fruit showing the position of the embryo in relation to other structures. *c*, Cotyledon; *dø*, degenerating ovule; *?*, endosperm; *el*, elongated conducting cells of the endosperm; *ha*, haustorium; *hy*, hypocotyl; *ø*, ovule; *pl*, placental column; *pl'*, plumule; *s*, suspensor; *vt*, vascular tissue of the placentum.

of such a pattern of development are to be seen in the expansion of the cotyledons, the development of the plumular leaves and the complete maturation of the vascular elements in the axis, cotyledons and the first pair of epicotylary leaves. The large quantity of nutrients supporting the growth of the embryo into a massive seedling are obviously transported through the endosperm. There appears to be no need for deposition of reserves in the endosperm cells themselves. It has also been observed that reserves are not deposited in the embryonal tissues as in exalbuminous seeds either. Furthermore the endosperm fails to grow beyond a certain volume and is found in mature fruits as a small whitish mass adjoining the placental column. It is of interest to investigate whether the absence of stored reserves either in the endosperm or in the embryo is a characteristic feature of other viviparous mangroves also. The essential features of vivipary in

Avicennia lie in the fact that the endosperm is mainly a conductive tissue.

Department of Botany, Presidency College, Madras, *October* 6, 1961.

B. G. L. SWAMY.
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CRITERIA FOR GRADING RESISTANCE OF SUGARCANE VARIETIES TO RED ROT (*GLOMERELLA TUCUMANENSIS*)

In India, red rot develops in the standing cane and the grading of varieties for resistance to the disease is done in terms of 'average lesion length' by what is known as the 'plug method'.[1] Examination of several hundred varieties over a number of seasons at this Institute has shown that the length of the lesion produced in a host variety is highly variable and therefore the criterion is unsatisfactory for assessment. It could not be otherwise as the disease syndrome is controlled by both plasmatic and mechanical resistance, more so by the former, and lesion length is at best a rough expression of the latter. The different characters of the syndrome were scored in 681 varieties examined between 1958 and 1960 in order to assess their relative importance in relation to overall damage.

The mechanical resistance which is located at the nodes comprises, (i) the ramification of vascular elements and heavy lignification of ground tissue which bar, to a greater or lesser extent, the transnodal extension of the primary lesion, and (ii) occurrence of septa in the water-conducting vessels which controls the migration of conidia and the consequent occurrence of secondary lesions. The plasmatic type of defence consists of a hyperergic reaction resulting in production of gums in advance of the hyphæ thus controlling the destruction of sacchariferous ground tissue and enzymatic inversion of sucrose. This type of resistance is reflected in the width of the lesion and the nature and amount of white spot development therein. Thus, the primary characters which appeared to indicate resistance were (1) width of lesion, (2) occurrence and nature of white spots and (3) the degree of nodal transgression.

Certain additional characters appeared important but they occurred only in some varieties and, when they occurred, confirmed the reaction indicated by the primary characters. In pithy varieties the pathogen was observed to destroy the pith rapidly and occupy the central core of the cane. In susceptible varieties it debouched into the parenchyma in the upper internodes, but in resistant varieties was contained by a severe gummy reaction of the fringe of parenchyma cells. Occurrence and type of nodal necrosis and development of cavities in the growth ring were other characters infrequently observed.

It was found that the scores for the three primary characters were highly correlated and the large number of varieties examined fell in only a few grades. Identical grades were obtained in the case of 127 varieties scored in 1957-58 and 554 varieties scored in 1959-60. It was observed that yellowing and drying of tops within the normal period of incubation was characteristic of only the highly susceptible grade which had a combination of the worst scores for all the characters, making it unnecessary to score such varieties for the various characters. Repetition of the test in the case of 77 varieties in a subsequent season showed that their reactions were constant, the degree of resistance of 17 varieties departing by just one step into the neighbouring grade.

Comparison of the grades of 127 varieties of 1957-58 according to the above criteria and those by the average lesion length method revealed wide divergence. Indeed, some of the varieties classed as susceptible by the criteria outlined here were resistant or moderately resistant by the average lesion length method. There could be no doubt of their grades since such varieties, when allowed to stand for a further period, showed signs of distress with yellowing and drying of tops. It is likely therefore, that the failure under cultivation of certain varieties passed as resistant after artificial inoculation might be due to the application of the unsatisfactory criterion of average lesion length in grading resistance, although, in some cases, failure due to the appearance of new, more virulent pathogenic strains in nature may not be ruled out.

A full account of the study with a detailed key for grading resistance based on the above characters is under publication elsewhere.

Sugarcane Breeding Institute, Coimbatore, *August* 31, 1961.

K. V. SRINIVASAN.
N. R. BHAT.

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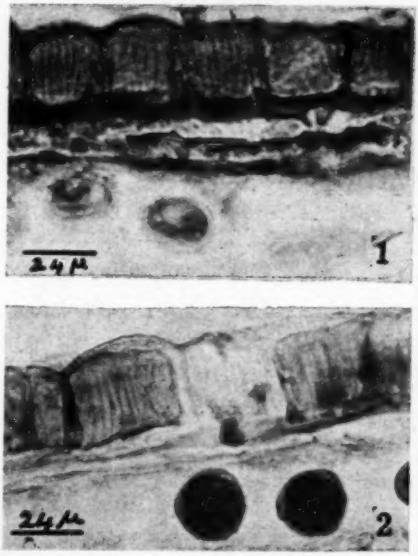
FIBROUS THICKENINGS IN THE ANTHER EPIDERMIS OF *WORMIA BURBIDGEI* HOOK.

THE structure of the anther wall has been well described. Maheshwari[1] has mentioned several interesting variations that are seen in epidermis, endothecium and middle layers. In the majority of angiosperms, the anther wall has an epidermis and a prominent endothecium with fibrous thickenings at the time of dehiscence. Endothecial cells with spiral thickenings are presumed to function in the dehiscence of the anthers, bringing about the dissemination of pollen grains. Some species lack fibrous thickenings in the endothecial layer, others have thickenings on the cell-walls of middle layers of the anther. Still other species have fibrous thickenings in the cells of both endothecium and middle layers.

During an embryological investigation of Dilleniaceæ an unusual structure of anther epidermis was observed in *Wormia burbidgei* Hook. Sections which were cut at 5–10 μ showed that at the time of dehiscence the mature anther wall has a prominent epidermis, with or without a poorly retained endothecial layer. The epidermal cells are filled with tannin, while the outer cell-wall is cutinized (Fig. 2). In the thinner sections either very little tannin was visible, or sometimes the tannin deposit was absent. In these sections the fibrous thickenings were clearly seen. These do not develop in the cells of the endothecium, even if that tissue is present at the time of dehiscence. The development of the fibrous thickenings was studied in transverse as well as longi-sections of the anthers. The epidermal cells accumulate tannin material even before the differentiation of microsporocytes. Attempts to dissolve and remove the tannin from these cells by treating them with $FeCl_2$ and lead nitrate were partially successful in young as well as mature anthers (Figs. 1 and 2).

As far as the author is aware this is the first instance where the fibrous thickenings have been observed in the epidermal cells of the anther. There is no mention of such a feature in the previous literature on the embryology of Dilleniaceæ.[2–6] However, the presence of a prominent epidermis has been recorded in all the species that are investigated so far. In case of *W. burbidgei* and *Dillenia*[5,6] the endothecium lacks the fibrous thickenings even when it is persistent at the shedding stage. In *Hibbertia stricta* the endothecial cells are fibrous; and only some of the cells have fibrous thickenings in *H. billarderii*.[6] In *Acrotrema arnottiannum*[4] also only some endothecial cells develop fibrous thickenings as in *H. billarderii*. In order to determine the exact variation of the occurrence of fibrous thickenings in the wall layers of the anther the other genera of the family are being studied. The indefinite hypogynous stamens in *W. burbidgei* are basally fasciculate; and they dehisce by the formation of apical pores at the free end of stamens. Similar conditions have been reported for several species of *Wormia*.[7,8] The formation of fibrous thickenings in the epidermal wall of the anthers may function to provide mechanical strength for the anther; and the endothecium does not take part in the dehiscence of the anthers.



FIGS. 1–2. Longisections of young and mature anther wall in *Wormia burbidgei*. Note the absence of tannin in one of the cells in Fig. 2.

Department of Botany, A. N. RAO.
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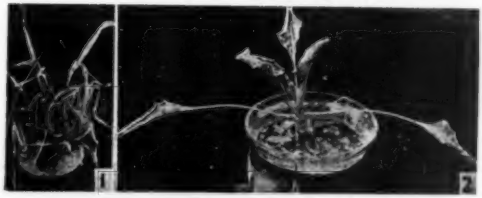
THE STANDARDISATION OF SAND CULTURE TECHNIQUE FOR THE STUDY OF MACRO AND MICRO-NUTRIENT (TRACE) ELEMENT DEFICIENCIES UNDER INDIAN CONDITIONS

IN SPITE OF the great utility of the sand culture technique[1] in elucidating problems of macro and micronutrient requirements of plants and of nutrient availability in soils, apart from some sporadic work,[2,3] no systematic investigation has been undertaken to standardise the technique under Indian conditions; almost no information is available on the suitability of any Indian sand for micronutrient studies. Owing to the difficulty in eliminating contaminants and the preponderance of fine particles, sand from riverbeds was not found suitable for refined culture work.

Extensive trials[4] showed that water washed silica sand of the grain size 0·25 to 0·84 mm., obtained from the sandstone beds in Allahabad and Banda, in U.P., could be used as a suitable basic material, the white sand being preferred to tinted as the latter contained as much as 1440 p.p.m. iron compared to 75 p.p.m. in white sand. The purification procedure of the sand comprised one or more of the following: (*i*) cold treatment with 4% HCl; (*ii*) hot treatment with 17% HCl; (*iii*) hot treatment with 17% HCl and 1% oxalic acid; (*iv*) hot treatment with 2% KOH. Hot treatment was given by passing steam generated in an autoclave for 4 hours at a pressure of 20 lb./sq. inch in sand-acid/-alkali mixture contained in wooden vats or large clay pots painted with bitumen. With treatment (*i*) mild and with treatment (*ii*) severe effects of the deficiencies of K, Ca, Mg, P, S and N were obtained in cucurbits, brassicæ, legumes, cereals, etc.[4] Severe deficiencies of iron in barley, radish, cauliflower and mungel wurzel and of boron in cucurbits were obtained by giving treatment (*iii*) twice. By giving treatment (*iii*) thrice and treatment (*iv*) twice in the order (*iii*), (*iv*), (*iii*), (*iv*), (*iii*) severe copper deficiency was obtained in barley (Fig. 1) and manganese deficiency in oats, barley, paddy and mungel wurzel (Fig. 2). In the former the last step of sand purification was carried out in pyrex glass containers.

For obtaining macronutrient, iron, boron and manganese deficiencies clay flower pots painted thrice with bitumen and water passed through 3 deionising units, each containing a column of Zeocarb and De-Acedite resins were suitable. Pyrex containers were required for obtaining acute effects of manganese and copper deficiencies; the latter also required deionised water which had been distilled in all pyrex glass containers. Free drainage was provided and appropriately purified nutrient solutions applied daily



FIGS. 1-2. Fig. 1. Copper deficient plants of barley showing death of the growing points, failure to unroll and withering of young leaves. The older leaves are green and plants bushy in appearance. Fig. 2. Manganese deficient mungel wurzel plant showing mottled upright leaves, triangular in outline owing to forward curling of leaf margins.

instead of a few times[2,3] in the growing season in order to maintain the nutrient supply at a known desired level. The full nutrient solution contained: K, 156; Ca, 160; Na, 31; Mg, 48; P, 55; S, 64; N, 168; Fe, 5·6; Mn, 0·55; Cu, 0·064; Zn, 0·065; B, 0·37; Mo, 0·05; Co, 0·006; and Ni, 0·006 p.p.m.

Department of Botany, S. C. AGARWALA.
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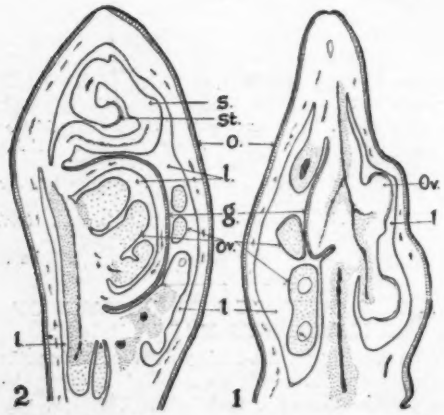
A GYNOECIUM IN THE OVARY OF *RHINANTHUS MAJOR* EHRH.

WHILE woking on the embryology of *Rhinanthus major*, two interesting cases of a gynœcium inside the ovary were observed. In a cross section the normal ovary is biconvex, discoid; having axile placentation and two compressed loculi. There are about seven disc-shaped ovules in each loculus, arranged alternately in two rows. The ovule is attached with a nodular funiculus to a similarly shaped region of the placenta. Reduction in the number of the ovules and their curious disposition so as to have the maximum advantage of the available space in the loculus, makes the embryology of this plant very interesting. Further studies are in progress and will be published elsewhere.

The tissue of the placenta, in the two abnormal cases, develops an ovary on it. It arises as a compact, elongated structure (Fig. 1) and is bounded by a conspicuous epidermis filled with a brownish substance, simulating the epidermis of the parent ovary. A cavity arises in this structure which on its floor bears a number of apparently normal ovules (Fig. 2). Anatomy of the envelope that covers these ovules is similar to that of the parent ovary wall. Hence, this new structure is interpreted as an ovary within an ovary. Furthermore, from its apex, it develops a long coiled style bearing a characteristic stigma (Fig. 2). As the abnormal ovary develops, the two loculi of the original ovary are more or less reduced in size and one may be partly obliterated (Fig. 2). It is not certain whether the abnormal gynœcium proliferates in order to expose its stigma to the pollen grains. The cavity of the ovary, however, communicates with the loculus in which it develops through an opening at the base of its style where it is detached from the placenta. It is likely therefore, that the pollen tubes entering the loculus may also reach to the ovules covered over by the abnormal ovary.



FIGS. 1–2. *Rhinanthus major* Ehrh. Abnormal ovaries, × 22. Fig. 1. L.S. ovary; note the ridge-like initial of another ovary on the placenta. Fig. 2. Same, abnormal gynœcium. (*g* = abnormal ovary; *l* = locule; *O* = ovary; *ov* = ovule; *S* = style; *St* = stigma.)

Abnormalities of a similar nature in the reproductive organs of the flower have been reported in a number of plants. To mention a few of them: Farooq[1] found on the gynœcium of *Citrus medica* attached anthers and 'extra ovarian ovules' and Shukla[3] described an attached stamen and an 'extra locular ovule' on the ovary wall of *Peganum hermala*. In this plant he also noted an open carpel having a stamen attached to the carpellary margin which ascends up to the stigma. Johri and Tiagi[2] observed pollen mother cells and pollen grains in the ovary wall of *Cuscuta reflexa*.

We are grateful to Prof. C. V. Subramanian for encouragement and to Dr. Y. D. Tiagi of the Sagar University for the material of *Rhinanthus*.

Department of Botany, University of Rajasthan, Jodhpur, *August* 29, 1961.

B. TIAGI.
KAMAL MOHNOT.

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THE EFFECT OF GROWTH-REGULATING SUBSTANCES OF THE ROOT EXTRACT OF WATER HYACINTH (*EICHHORNIA SPECIOSA* KUNTH.) ON JUTE (*CORCHORUS CAPSULARIS* LINN.)

THE presence of growth-regulating substances in the root extract of water hyacinth has been indicated previously from this laboratory (Sircar and Kundu, 1959, 1960; Chakravarty, 1960). The exact chemical nature of the substances present in the root is not yet known. Chromatographic separation of the extract has shown the presence of several substances including indole compounds, but one of them separated at R.f. different from indoles and gibberellins has shown remarkable properties of increasing both root and shoot growth at the same concentration (Sircar and Roy, 1961). Pending chemical identification it is felt desirable to study the effect of the extract as a whole on growth and fibre production in jute. Accordingly a pot culture experiment has been carried out in the experimental garden of the Department of Botany, University of Calcutta.

Pure line seeds of jute were sown in earthenware pots containing garden soil and leaf manure. The seedlings were subsequently thinned to two plants per pot. Twenty plants were taken in each of the treatments. Root extract of water hyacinth prepared according to the method described previously (Sircar and Kundu, 1960) was sprayed once a week to the foliar parts of ten days old plants by means of a Holm's atomiser. The height, basal circumference of the stem, number of leaves and nodes were recorded at regular intervals. The fibre of the plants was extracted by chemical treatment. The results are presented in Table I.

TABLE I

Height and basal circumference (in cm.), number of leaves and nodes and fibre yield (in gm.) of jute (Corchorus capsularis *Linn.*) *after treatment with root extract of water hyacinth (RWH). Average of twenty plants*

	No. of days after first application								Quantity of fibre per plant	Percentage of fibre against fresh weight of plant
	21	28	35	42	49	56	63	70		
Shoot Height										
RWH ..	72·0 ±0·37	90·11 ±0·19	115·08 ±0·56	135·17 ±0·40	149·91 ±0·64	178·68 ±0·42	202·94 ±0·72	220·88 ±0·77	9·40 ±0·03	4·63
Control ..	63·42 ±1·24	75·20 ±0·65	99·23 ±0·66	117·80 ±0·81	131·44 ±0·83	156·08 ±0·90	179·07 ±0·89	199·00 ±0·89	6·60 ±0·92	3·97
Basal Circumference										
RWH ..	2·36 ±0·01	3·14 ±0·02	3·78 ±0·02	4·36 ±0·09	5·02 ±0·12	5·76 ±0·10	6·98 ±0·12	7·59 ±0·24	..	..
Control ..	2·20 ±0·03	2·66 ±0·10	3·07 ±0·12	3·68 ±0·23	4·16 ±0·05	4·90 ±0·06	5·35 ±0·19	6·12 ±0·19	..	..
No. of leaves										
RWH ..	26·85 ±0·16	32·65 ±0·15	39·45 ±0·31	446·80 ±0·11	0·25 ±0·21	59·10 ±0·07	68·10 ±0·10	80·30 ±0·18	..	..
Control ..	25·75 ±0·31	30·00 ±0·27	35·00 ±0·14	40·45 ±0·15	44·05 ±0·20	50·20 ±0·18	57·95 ±0·32	68·15 ±0·27	..	..
No. of nodes										
RWH ..	21·95 ±0·82	28·85 ±0·34	34·00 ±1·01	41·55 ±0·77	44·25 ±0·53	54·30 ±0·69	62·10 ±0·15	74·25 ±0·88	..	..
Control ..	21·05 ±0·43	27·40 ±0·48	32·10 ±0·69	38·35 ±0·82	40·21 ±0·21	45·00 ±0·12	52·31 ±0·16	63·04 ±0·14	..	..

The height of the plants is increased after treatment with the root extract (RWH). During the first two to three weeks of application the plants were indistinguishable from the control, the difference becoming prominent from the fourth week onwards. The basal circumference (thickness) of the stem is markedly increased (Fig. 1). The total number of leaves and nodes on the main stem show an increase over the untreated plants. Abscission of leaves was prevented to a considerable extent by this treatment. No marked change in the shape and size of the leaves is observed. The quantity of fibre production and its percentage against the fresh weight are greater than the control.

These preliminary results from a pot culture experiment appear interesting and are likely to be of economic importance. It may be mentioned here that the effect of gibberellic acid on increased growth and fibre production of jute plants has been previously reported (Sircar and Chakravarty, 1960), but the obvious limitation in the use of gibberellic acid is the high price and difficulty in production from the fungus *Gibberella fujikuroi* (Saw.) Wr. The separation and identification of the active compound from the root of water hyacinth is worth pursuing further to determine its utility as a

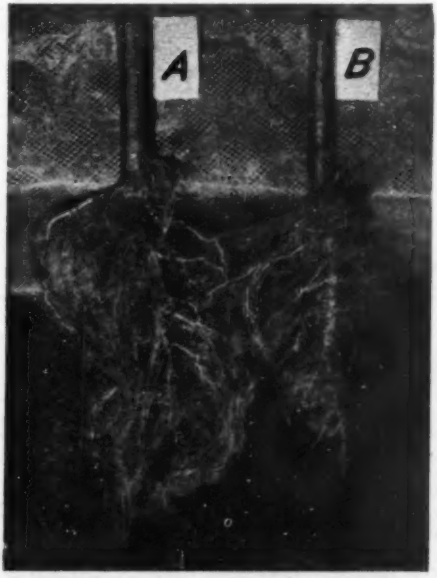

FIG. 1. Showing basal circumference (thickness) of the stem of jute plants at harvest. Treatments : A = RWH and B = Control.

growth-regulating substance. Work in this direction is now in progress in this laboratory.

Department of Botany, S. M. SIRCAR.
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PTERIDOPHYTES OF NAGPUR

THE neighbourhood of Nagpur is an ideal place for systematic botanical exploration. Particularly, the pteridophytes of this region have received very scanty attention.

As a result of their own investigations, the authors are in a position to present here the following data (Table I) about the representation of these plants in the flora of this part of our country.

TABLE I

Division: Pteridophyta

Class	Order	Family	Genus	Species	Locality
1 Equisetineæ	1 Equisetales	1 Equisetaceæ	1 *Equisetum* L.	1 *E. debile* Roxb.	1 Ambazeri
					2 Koradi
2 Lycopodineæ	2 Isoetales	2 Isoetaceæ	2 *Isoetes* L.	2 *I. coromandelina* L.	1 Umred
					2 Mansar
3 Filicineæ	3 Ophioglossales	3 Ophioglossaceæ	3 *Ophioglossum* L.	3 *O. nudicaule* L.	Ambazeri
				4 *O. fibrosum* Schum.	Seminary Hill
	4 Filicales	4 Polypodiaceæ	4 *Adiantum* L.	5 *A. lunulatum* Burm.	Common
			5 *Cheilanthes* Sw.	6 *C. tenuifolia* Sw.	Ramtek
		5 Marsileaceæ	6 *Marsilea* L.	7 *M. minuta* L.	Common
				8 *M. quadrifolia* L.	Common
		6 Salviniaceæ	7 *Azolla* Lam.	9 *A. pinnata* R. Br.	Common

Of these, *Azolla pinnata* R. Br. and the two species of *Marsilea* L. are very common and abundant. *Adiantum lunulatum* Burm., though not so abundant, is also not uncommon here. *Equisetum debile* Roxb. and *Isoetes coromandelina* L., which have a restricted distribution, grow in great abundance at their places of occurrence. Still less frequent and very rare are the two species of *Ophioglossum* L.

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College of Science, S. A. PARADKAR.
Nagpur, *July* 12, 1961.

SPOROPHYTE OF *JUNGERMANNIA VIRIDIS* KASH.

WHILE making collection of mosses at Nainital the author came across some plants of *Jungermannia viridis* with young sporophyte. As far as is known to the author only the gametophyte of this liverwort has been described (Kashyap and Chopra, 1932) and no reference is available of its sporophyte. The plants were brought to the laboratory and cultured in petri-dishes on sand medium. The plant resumed their normal growth and the young sporophyte developed to maturity.

The archegonia are born at the apex of the female plant forming a terminal cluster subtended by the perianth. Their size varies from 140–160 μ in length and 24–32 μ in breadth at the base (Figs. 4 and 5).

Only one sporophyte grows to maturity occupying the terminal position (Fig. 2). It is differentiated into foot, seta and capsule. When young it is enclosed by the perianth and calyptra. At this stage the seta is very short. A young capsule is whitish with a purple tint at the base, becoming globose, reddish to dark-brown at maturity and attaining a diameter of 0·5–0·9 mm. At maturity the seta elongates rapidly raising the capsule much above the perianth. The seta generally attains a length of 4 mm.

The liberation of spores is effected by the dehiscence of the capsule into four valves to the base (Fig. 3). No other special mechanism of spore dispersal is observed. The wall of capsule is two layers in thickness, the outer having columnar thickenings which appear nodular in surface view. Inner layer is provided with semi-annular thickenings (Fig. 6).

The spores are yellow to light-brown in colour, globose, 10–16 μ in diameter (Fig. 10).

Elaters are long with blunt ends, having bispiral thickening (Fig. 9). They are 90–110 μ long and 8 μ broad. The spore elater ratio is 2 : 1.

FIGS. 1–10. *Jungermannia viridis* Kash. Fig. 1. Sterile shoot. Fig. 2. Female shoot with mature sporophyte: *P*, perianth; *S*, seta; *C*, capsule. Fig. 3. Dehiscence of capsule. Fig. 4. Young capsule, archegonia are also seen. *F*, foot; *Cal*, calyptra. Fig. 5. Archegonia with fertilized egg. Figs. 6–7. Inner and outer layers of capsule wall. Fig. 8. C.S. of capsule wall. Fig. 9. Elater. Fig. 10. Mature spore.

The author is grateful to the late Prof. S. K. Pande for suggesting and taking keen interest in this investigation.

Department of Botany, C. K. C. S. PILLAI.
University of Saugar,
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A VIRUS DISEASE OF *ODONTONEMA NITIDUM*

THREE varieties of the ornamental shrub *Odontonema nitidum* (Jacq.) Kuntze are usually found in South Indian gardens. One variety has variegated leaves with bright-yellow netted veins (Fig. 1). The leaves of another variety are dark-purplish on the upper surface and purple-coloured on the lower surface (Fig. 2), while the third variety has reddish-green leaves with wavy margins and blotched with green.

The netting of the leaves in the first variety mentioned above has generally been considered a genetic variation. However, a close examination of the vein-clearing symptoms made us suspect that this might be due to infection by a virus. Experiments were, therefore, conducted to ascertain whether the variegation was transmissible. Mechanical inoculation with sap from yellow-netted variety on the purple-leaved variety was not successful. Twigs from the yellow-netted variety were, therefore, wedge-grafted on the purple-leaved variety and the wavy-margined variety. All the leaves from the stock varieties were clipped off immediately after grafting. In about four weeks young leaves emerging from the stock varieties showed faint-yellow netting. The netting became more conspicuous as the leaves matured. The scions were clipped off a few days after the grafts had established. The plants have continued to produce yellow-netted leaves with purple background (Fig. 3).

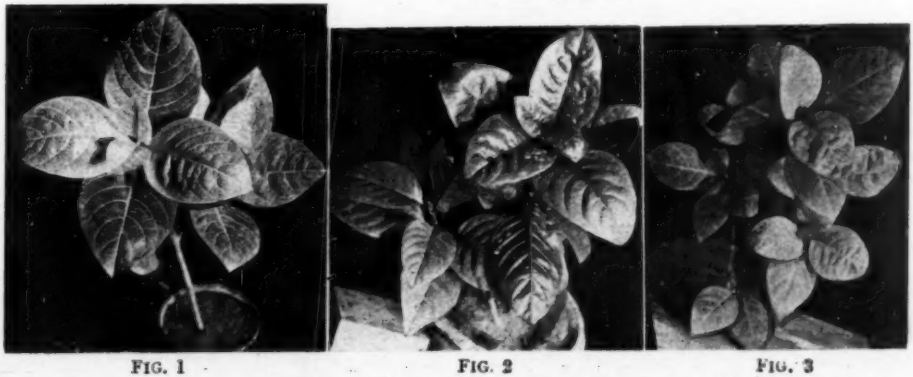

FIG. 1 FIG. 2 FIG. 3

FIGS. 1–3. *Odontonema nitidum*. Fig. 1. Yellow-netted variety. Fig. 2. Purple-leaved variety. Fig. 3. Netting produced on purple-leaved variety as a result of graft inoculation.

Similar grafts were made on *Adhathoda vasika* Nees. plants. The grafts were successful, but the netting was not transmitted.

Two viruses which cause yellow net symptoms on their hosts have been described by Sylvester (1948 and 1954). These are the beet yellow net virus (Sylvester, 1948) and the tomato yellow net virus (Sylvester, 1954). The former was not sap-transmissible while the latter was apparently so. Both were transmitted by *Myzus persicæ* (Sylvester, 1949, 1954). It is not possible to say whether the present virus is related to the above two without further experiments, which are in progress. A vector for the present virus, if present in nature, does not appear to be very efficient, as no natural transmission of the disease has been observed, even though the purple-leaved variety and the netted variety are generally grown in close proximity in gardens. The virus is in the meanwhile tentatively named the *Odontonema yellow net virus*.

Plant Pathology Section, K. RAMAKRISHNAN.
Agricultural College and C. P. SUBRAMANIAN.
Research Institute,
Coimbatore-3, *February* 27, 1961.

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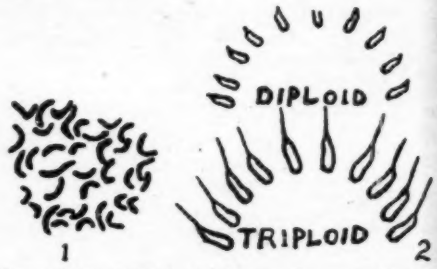
AN AUTO-TRIPLOID OF RICE AND ITS PROGENY

IN a culture of rice, *O. sativa* (Orissa improved variety T. 1242), an off type semisterile plant with large tip awned spikelets was observed. This rice plant was isolated and somatic chromosome number determined. Since considerable difficulty was experienced in getting proper spreading and staining of chromosomes, pretreatment of root-tips in cold water with alphabroma-naphthalene for 10-15 minutes was adopted. Meiosis was also studied in the PMC of this culture fixed in propionic alcohol (1 : 3) containing a trace of ferric acetate and smears were prepared in propiono-carmine. As shown in Fig. 1, the somatic chromosome number was found to be 36, showing that it was a triploid, since the diploid number in *O. sativa* is 24. Such spontaneous triploids have been obtained previously in rice by Morinaga[1] as well as by Ramanujam[2] and these authors have concluded that such triploids had probably originated by union between a normal and an unreduced gamete. The effect of triploidy on the different plant parts, spikelets and pollen sterility is characteristic in rice as in other crops. In the present instance, triploidy was correlated with increase in plant height, as well as in ligule and spikelet sizes. The rice variety T. 1242 is nearly awnless, with occasional occurrence of tip awns. A comparison of the spikelets from the normal diploid plant and from the triploid plant is presented in Fig. 2.



In meiosis, 12 trivalents can be expected but is usually not found. The frequency of trivalents as determined from 50 cells gave a mean of 9·4 per cell. There is variation from a maximum of 12 trivalents to 8. The frequency of trivalents, bivalents and univalents observed is given in Table I.

TABLE I

No. of cells	Trivalent (III)	Bivalent (II)	Univalent
6	12	..	..
4	11	1	1
8	10	2	2
22	9	3	3
10	8	4	4
Mean per cell	9·4	2·5	2·5

Fertility of pollen was estimated to be 20% as determined by iodine staining, in a sample of 2907 pollen grains. Spikelet fertility was comparatively lower, being below 5% in the main crop season. The germination of the seeds collected was poor and survival of the seedlings was also poor. Both these features can be expected from the triploid nature of the plant. Ramanujam[2] has already recorded that aneuploid progenies are obtained on open pollination of triploid rice cultures and that plants having chromosome number in excess of $2n = 26$ have retarded growth. Since aneuploids of crop plants are of theoretical interest, excised embryos were germinated in the nutrient agar media, as suggested by Randolph.[3] This technique proved to be useful and can be used on a large scale. However, in the first attempt, only three adult plants labelled as A, B and C were grown to maturity. The somatic

chromosome number in these was found to be A = 24 + 2, B = 24 + 2 and C = 24 + 3. Meiotic studies are being used for identification of the type of aneuploidy. It is well known that two aneuploids having same chromosome number may be entirely different, since the extra chromosomes could be different members of the genom. The next step is to identify which of the chromosomes are present in excess, and this is being done by studying the pairing behaviour at meiosis in the aneuploid plants. The significance of the present work is in the application of embryo culture technique for securing new primary trisomics of rice and this work is being continued.

This work was carried out at the Central Rice Research Institute, Cuttack and the author is indebted to the Director for facilities and to Shri S. Sampath for guidance, and to the State Department of Agriculture, Mysore, for the deputation.

Agric. Res. Station, Nagenahalli, Mysore-3, *March* 10, 1961. B. K. KARIBASAPPA.

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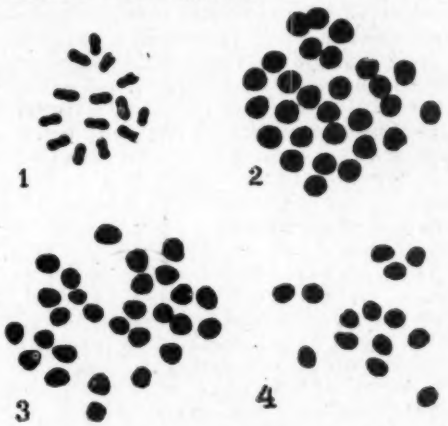
CHROMOSOME NUMBERS IN THE GENUS *CORCHORUS*

OF the eight species of *Corchorus* reported from Indo-Pakistan sub-continent, the chromosome numbers of seven species are known and reported to be $2n = 14$.[1-7] The chromosome number of a recently reported species was found to be also $2n = 14$.[8] Chromosome examination of some exotic species revealed the presence of a tetraploid species, *viz.*, *C. siliquosus*, L. from Jamaica.[7] The present study was undertaken to find out the chromosome numbers of some more species and confirm the previous finding in respect of chromosome number of two species, *e.g.*, *C. siliquosus*, L. and *C. tridens*, L. from root-tips. The somatic chromosome numbers of five species, two from Australia, namely, *C. walcottii*, F.v.M. and *C. elachocarpus*, F.v.M., one each from South Africa, Jamaica and Poland, namely, *asplenifolius Burch* Trav., *C. hirsutus*, L. and *C. hirtus*, L. respectively were determined and of these *C. hirtus* turned out to be a tetraploid having $2n = 28$ (Fig. 2) and the remaining four showed the diploid chromosome number, *i.e.*, 14 (Fig. 1). The previous chromosome report was also confirmed (Figs. 3–4). Root-tips were collected from germinating seedlings grown in Petri-dishes and chromosomes were stained in leucobasic fuchsin after prefixation in para-dichlorobenzene for 2 hours.



FIGS. 1–4. Somatic chromosomes from root-tip cells of: Fig. 1. *Corchorus walcottii* ($2n = 14$). Fig. 2. *C. hirtus* ($2n = 28$). Fig. 3. *C. siliquosus* ($2n = 28$). Fig. 4. *C. tridens* ($2n = 14$) (×1,625).

Our thanks are due to Mr. W. Hartley of C.S.I.R.O., Australia, Mr. C. R. Proctor, Institute of Jamaica, Miss E. R. Roux, University of Witwatersrand, Johannesburg, for their providing us the seeds of the various *Corchorus* species used in the present investigation.

Dept. of Botany, Univ. of Sind, *April* 24, 1961. AHMAD SHAMSUL ISLAM. FEROZA QAIYUM.

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SPHAEROTHECA ON TWO MEMBERS OF EUPHORBIACEAE FROM HYDERABAD (INDIA)

THE members of Erysiphaceæ[1] are rather rare in hotter parts of the world when compared to their occurrence in temperate regions. In hotter parts of India powdery mildews are chiefly known to occur in the asexual stage (Oidium) alone. But occasional cold spells might induce

them for perithecial production. A thorough search of the powdery mildewed plants is likely to reveal more perfect stages which were hitherto not known to occur.

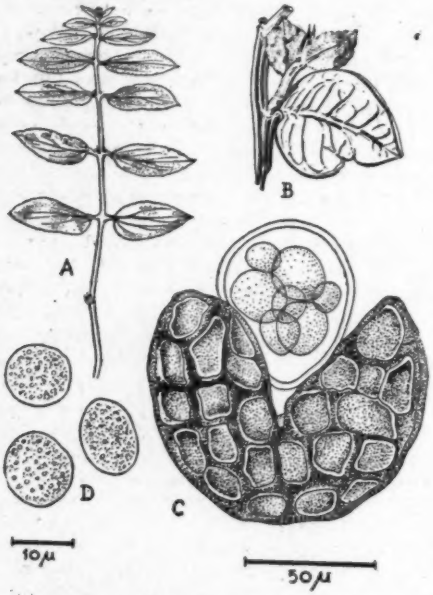

FIG. 1. A. Infected plant of *Euphorbia hirta*. B. Infected plant of *Pedilanthus tithymaloides*. C. Cleistothecium with a single ascus. D. Ascospores.

In this note, perithecial stage of a fungus which was discovered on *Euphorbia hirta*, L. and *Pedilanthus tithymaloides*, Poit. respectively is described. On examination the perithecial stage was found to belong to the genus *Sphærotheca* which is reported for the first time. In an earlier paper[2] the 'Oidium' stage was recorded on the above-mentioned hosts.

Sphærotheca euphorbiæ (CAST.) SALMON

Fruiting eiphyllous, abundant, mature perithecia dark-brown, spherical to globoid, 40·8–102·0 μ in diameter, appendages flexuous, pale-brown and narrower towards the apex, 2–3 septate. A single, large, oval to globose ascus, subhyaline, apedicellate, with a basal papilla, 30·0–67·5 × 22·5–52·5 μ. Ascospores 8 hyaline (golden-yellow), 1-celled, oval to elliptic, with granular contents and oil globules, and in various stages of development, 12·0–21·0 μ in diameter.

On the living leaves of *Euphorbia hirta*, L. and *Pedilanthus tithymaloides*, Poit. 21-12-1960, P. N. Rao, Secunderabad, O.U.B. Herb. 'Hy' No. 142, 143.

Note :—Fruiting on *Pedilanthus tithymaloides* is hypophyllous, perithecia measure 81·6–136·0 μ in diameter, asci 47·6–85·0 × 34·0–57·8 μ and ascospores 13·5–18·0 μ.

My grateful thanks are due to Dr. M. A. Salam, Head of the Department of Botany, for his encouragement.

Mycology and Plant Pathology Sec., P. N. RAO.
Botany Department,
Osmania University,
Hyderabad-7 (A.P.), *June* 22, 1961.

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INHERITANCE OF HAIRY CHARACTER ON PODS IN BLACK GRAM (*PHASEOLUS MUNGO* L.)

STUDIES of inheritance of character have been widely conducted in genus *Phaseolus*. Bose (1939) carried out flower and seedcoat studies in *Phaseolus aureus* (Roxb.). Singh and Mehta (1953) found that in *Phaseolus aureus* L. the difference in leaf type was due to one pair of gene. As given in the *Report of Indian Council of Agricultural Research* (1950-51) interspecific crosses were also attempted between *P. radiatus* and *P. mungo* at Annamalai University and the hybrids obtained as a result were found to possess characters of both the parents, *viz.*, vigorous growth, luxuriant leaves and high seed yield. Sen and Ghosh (1959) studied various characters in green gram.

In *P. mungo* the authors came across distinct types which had hairy as well as non-hairy pods. Crosses were made to study the inheritance of hairy pod character and it has been found that 'non-hairy' is simple recessive to hairy. The F_1 generation had entirely hairy pods. In F_2 the segregation was in the ratio of three hairy against one non-hairy as seen from Table I.

TABLE I

Segregation ratio in F_2 generation

Characters	Observed population	Expected population	d	d_2	$X^2 = \frac{d^2}{e}$ (3:1)	P. value
Hairy	573	571·5	+1·5	2·25	$\frac{2·25}{571·5} + \frac{2·25}{190·5}$ = ·016	·80 to ·90
Non-hairy	189	190·5	−1·5	2·25		
	762	762	..	..		

In F_3 generation 234 hairy and 79 non-hairy were obtained which clearly confirmed the finding of F_2 generation.

Section of the Economic Botanist, G. N. PATHAK.
(Oilseeds) to Govt., U.P., K. P. SINGH.
Kanpur, *June* 8, 1961.

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REARING OF MORE THAN ONE GENERATION OF UNIVOLTINE SILKWORMS

DUE to extremes of climatic conditions prevalent in the Punjab, Himachal, Jammu and Kashmir, the multivoltine races of silkworm cannot be reared successfully. The univoltine races commonly reared in this region undergo a long duration of egg diapause with the result that only one crop of silk can be procured although climatic conditions during a greater part of the year are favourable for rearing more than one generation particularly in the lower Himalayan region where silkworm food, the mulberry tree, can be grown in abundance. It was, therefore, felt that if the diapause of univoltine eggs was terminated artificially and the larvæ obtained were reared successfully more than one crop of silk could be obtained in a year. In the monsoon season when natural mortality among the larvæ was likely to be high and in the winter, when rearing was not possible without heating the culture rooms, the eggs could be allowed to remain in natural diapause. To that end experiments were conducted in the laboratory and effort was made to rear more than one generation of univoltine silkworms.

Over-wintered eggs of the univoltine race, Cevenne Jaune, No. 45, were procured from the Department of Industries, Punjab, and were hatched at 25 (± 0·5)° C. The larvæ were reared at that temperature as a normal spring brood. In the adult stage they laid eggs which were in diapause. In order to terminate diapause (Henneguy, 1904; Kogure, 1933) the procedure given was adopted: eggs were kept at 25° C. for 24 hours and then soaked in 2% formaline solution which ensured better fixation on the cardboard pieces on which those were laid; eggs were dipped in 15% hydrochloric acid (Sp. gr. 1·075) at 46° C. for 5 minutes, washed in water and were kept at 25° C. for incubation; the eggs hatched within 12 days.

The larvæ were reared at 25° C. They completed development in 32 days (25·9 for the first brood) and spun cocoons successfully. On emergence the moths laid eggs which were also in diapause. Those eggs were again treated in the same manner as mentioned above. The third brood larvæ also spun cocoons successfully. The moths on emergence laid eggs but further rearing was discontinued as the monsoons set in.

All the three broods were reared on leaves of *Morus alba* seedling variety. The average weight of larvæ and the silk shell produced by them were recorded for comparison between the three broods and those of the multivoltine races reared in Mysore by Sharada and Bhat (1956).

The larval weight of the 1st, 2nd and 3rd brood larvæ was 4·39, 3·46, 3·23 gm. and the silk produced was found to be 346·4, 193·0, 183·9 mg. respectively. Larvæ of the multivoltine race reared in Mysore under similar conditions attained 2·16 gm. body weight and produced 138·2 mg. of silk (Sharada and Bhat, 1956) which was significantly lower than that secreted by any of the three broods of the univoltine race including the 2nd and the 3rd brood larvæ hatched from eggs whose diapause was terminated by chemical treatment. It may be noted, however, that within the univoltine race silk yield of the 2nd and the 3rd brood was not as high as that of the 1st brood which apparently was associated with artificial termination of diapause.

The results indicate that rearing of more than one generation of the univoltine race of silkworm in the Punjab, Himachal, Jammu and Kashmir is possible and that the findings if tried in the field will have a great practical utility.

Govt. Agric. College and Research Institute, Ludhiana, *May* 29, 1961. A. S. ATWAL. A. N. VERMA.

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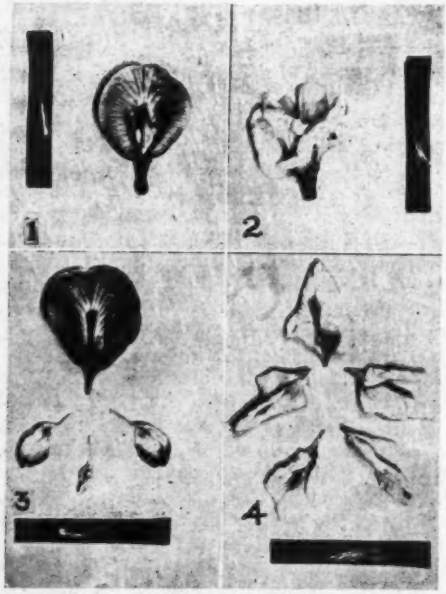
BREAKDOWN OF THE PAPILIONACEOUS STRUCTURE IN THE DOUBLE FLOWERS OF *CLITORIA TERNATEA* L. AND ITS INHERITANCE

Clitoria ternatea L. commonly known as the butterfly pea or mussel shell creeper is a perennial ornamental plant conspicuous for its large papilionaceous flowers. According to Pal (1960) there are varieties with deep indigo-blue, light purple and white flowers, and variation in

flower-shape is provided by the occurrence of single and double forms. The double flowers are conspicuous for their non-papilionaceous nature, the five petals being more or less of equal size and shape, and the 10 free stamens. In their floral structure they resemble the pattern of the subfamily Cæsalpinioideæ more than that of the subfamily Papilionatæ to which the *Clitoria* belongs (Figs. 1–4).



FIGS. 1–4

Figs. 1–2. Blue single and hyacinth tinge double flowers of *Clitoria* and nature of their stamens. Their different petals are shown in Figs. 3 and 4.

To study the genetic basis of the difference between the single and the double flower types, a variety with blue (ultramarine blue) single flower was crossed with another with hyacinth tinge double flower (Colour Chart of Maerz and Paul, 1950). The hybrid had blue double flowers with large equal sized petals and 10 free stamens indicating the dominance of the double type. In the F_2 generation, four types of plants with (i) blue double; (ii) hyacinth tinge double; (iii) blue single, and (iv) hyacinth tinge single appeared. The frequency of double : single type flowers was in the ratio of 202 : 76; χ^2 (3 : 1) = 0·8105; P = 0·50–0·30, showing monogenic dominance of the double flower over the single type. All the double flower had free stamens and the single flowers diadalphous 9 + 1 stamens.

In another cross between a white single closed flowered variety, where the standard petal was partially constricted towards the lower part, with a blue double variety—the hybrid had blue double flowers with free stamens. In the F_2 generation six types of flowers appeared and there too the frequency of double to single types was 102 : 20; χ^2 (3 : 1) = 0·5727; P = 0·50–0·30, showing monogenic dominance of the double type. This cross gave a beautiful large hyacinth coloured double flower type, which should find a place in the gardens.

The observations indicate that a mutation of a single gene has more or less broken down the papilionaceous nature of the *Clitoria* flower. As the single type is the predominant one and the wild *Clitorias* have single flowers, it is reasonable to assume that the double type originated through a dominant gene mutation. The change is comparable to that in the *radialis* mutant of *Antirrhinum majus* (Baur, 1924), where the mutant produced flowers with radial symmetry. The *radialis* mutant like most of the "large" mutations (macro-mutation) with drastic changes did not set seed naturally. But several examples are known, where even with conspicuous changes in flowers they are, nevertheless, fertile. The double flowered *Clitorias* produce a good number of fruits and seeds and being perennial in habit have the potentiality of surviving in nature.

Whatever may be the significance of such large mutations in the origin of species, genera and families, the double flowered *Clitoria* is an interesting example of the changes a single gene mutation may bring into the organs so vital in taxonomic classification, at the same time maintaining the viability and fertility of the plant.

Applied Botany Section, Indian Institute of Technology, Kharagpur (India), *June* 26, 1961.

NIRAD K. SEN.
R. KRISHNAN.

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REVIEWS

Solution of Equations and Systems of Equations—Pure and Applied Mathematics. (*A Series of Monographs and Text-books*). By A. M. Ostrowski. (Academic Press, New York and London; India: Asia Pub. House, Bombay-1), 1960. Pp. ix + 202. Price $ 6.80.

This monograph deals apparently with simple questions: Interpolation formulas, study of the roots of an algebraic equation, method of false position, various methods of iteration, linear difference equations and convergent product of matrices. Yet not only is the treatment extremely original; as the author writes in his preface, a great deal of unpublished material will be found throughout the book. At first sight one may be surprised to find in a series of texts meant for mature students of Mathematics a little volume of 200 pages devoted to questions which, most of them, can easily be grasped by a good student of the degree course. But a leading Mathematician like Professor Ostrowski was certainly well inspired to publish lecture notes intended primarily for the undergraduate level of universities in U.S.A. Not only students will find the study of them extremely interesting; lecturers themselves will, without any exception, derive considerable profit from their perusal. They will also appreciate a number of numerical exercises completely solved. It is not possible to analyse, in a short review, a book so rich in results. Suffice it to say that there is not one of the 18 chapters and of the 11 appendices which will not be found original. All contain some new point of view and all will inspire those teaching such subjects. Naturally one could not but expect from Professor Ostrowski admirable clarity of exposition and this in spite of concision. Such a monograph should be carefully studied by all those who wish so rightly to modernize the syllabuses of the degree, as well as of the post-graduate, course.

C. RACINE.

Advances in Space Science, Vol. 2. Edited by Frederick I. Ordway, III. (Academic Press, New York and London), 1960. Pp. xiii + 450. Price $ 13.00.

Ever since the first sputnik was made to orbit around the earth, space science has made significant strides and is moving at present with a fast and an accelerated pace. Considerations of national prestige, the military applications of rockets and the imagination that space travel evokes in the popular mind are some factors that have been responsible for the quick progress in this field, and these have rendered huge governmental grants to flow into space research organisations. A book that brings in the recent advances in space science will satisfy a timely need and the volume under review will therefore be welcomed by all scientists and space technologists.

The present volume comprises of review articles on important aspects of space science such as space physics, tracking, materials, electrical propulsion systems and attitude control, by well-recognised authorities in these fields. The first chapter of the book deals with space physics which the author defines as "a marriage of geophysics and astrophysics to rocket technology". Techniques and instruments devised to explore the nature of the earth's magnetic field, interplanetary and planetary fields; radiations from the sun and space; lunar, planetary and stellar features; interplanetary plasma; and micrometeories are considered in detail and data are provided that reflect Pioneer space and Explorer artificial satellite experience.

The tracking of satellites and space vehicles is the subject of the second chapter which examines both the basic scientific and technological purposes of tracking and the methods actually being employed. While the chapter is primarily concerned with artificial satellite tracking, attention is also accorded to the optical tracking of lunar and planetary probes. Chapter III entitled "Materials in space" deals with the materials to which a space vehicle is exposed to, like the gases beyond the atmosphere, high energy particles, meteoritic dust, electromagnetic radiation from the sun and stars, etc., and gives an extensive coverage of the materials that the designer should choose in order that the space vehicle might withstand the environment of outer space.

In separate chapters, two important approaches to electrical propulsion of space vehicles are examined, one concerned with plasma devices such as chemical rockets, nuclear rockets, natural plasma devices, etc., and the other with electrostatic (ion beam) systems. The problem of altitude control assumes great importance as satellites and spacecrafts become very complex and are required to perform ever more precise

investigation of geophysical and astrophysical phenomena. In the final chapter of the book the requirements for altitude control are first considered and these are followed by detailed analysis of altitude reference systems, torques acting on satellites and space vehicles and methods of controlling altitude.

In spite of security measure that prevent publication of all material relating the space research, the present volume contains valuable information on the scientific and technological aspects of space science. The printing and get-up of the book leave very little to be desired.

K. S. V.

The Chemistry of Heterocyclic Compounds, Vol. 15—*Heterocyclic Systems with Bridgehead Nitrogen Atoms*—Part I. By William L. Mosby. (Interscience Publishers, Inc., New York), 1961. Pp. 747. Price $ 48.00 ; Subn. $ 43.00.

Over a thousand ring systems with bridgehead nitrogen atoms are known, but the present volume is the first consolidated account of this most interesting field and it is a very valuable addition to the literature of organic chemistry. Both atom-bridged and valence bond-bridged systems containing nitrogen at a bridgehead are to be covered in two parts, and Part I deals with fused ring systems of the following types: (*a*) 3- and 4-membered rings fused to other ring systems; (*b*) fused 5/5 ring systems; (*c*) fused 5/6 ring systems with no extra hetero-atom. The literature has been surveyed systematically through Vol. 50 (1956) of *Chemical Abstracts*, and through the first half of 1958 of American and European journals; some work published in other journals after 1954 or 1955, such as Tilak's extensive work on pyrrocolines (indolizines) obtained from chloranil and 2, 3-dichloro-1,4-naphthoquinone, has also been included. The occasional impression one gets is an elaboration of the Ring Index, but this is perhaps unavoidable in a comprehensive review written with the main object of providing a source of information on individual members of a very large class. The plan of the book excluded a generalized treatment of such heterocyclic systems in relation to the influence of the nitrogen atom on ring stability and reactivity, the use of physical properties in structure determination, and the mechanism of reactions. However, there is a critical assessment of the validity of structures assigned to compounds on the basis of inadequate evidence, and attention is drawn to numerous problems requiring further investigation.

There seems to be no point in writing two resonance structures (II *or* III in the lower half of p. 51) with the statement that "Neither is, of course, a true representative of this nucleus". Structure (III) in p. 57 does not violate Bredt's rule which applies only to structures containing atomic bridges. Many repetitions of formulæ and the inclusion of erroneous formulæ, immediately followed by the correct formulæ which have superseded them, could have been avoided. In other ways also, such as the omission of the physical properties of numerous derivatives and a much shorter treatment of Ciba Yellow G and other obsolete and valueless dyes, the book could have been made available at a considerably lower price. A ring index and a subject index will appear at the end of Part II, but the absence of an index in Part I is to be deplored; since Parts I and II do not constitute a continuous story there should have been no difficulty in providing separate indices.

K. V.

Gas Chromatography. Edited by Henry T. Noebels, R. F. Wall and Nathaniel Brenner. (Academic Press Inc., New York and London), 1961. Pp. xvi + 463. Price $ 16.00.

Originating as a suggestion in a paper on liquid-liquid chromatography by A. J. P. Martin, gas chromatography (g.c.) has grown phenomenally in about a decade, into a powerful analytical tool, in research and industry. The pattern of development has followed on the lines of other important and commercially useful techniques like infra-red and n.m.r. spectroscopy. The basic ideas originate in academic institutions, industry takes them up, reduces the instrumentation problems to a routine. This in turn makes it possible for a wider application of the technique in basic research itself.

The book under review is a collection of 34 original papers, presented at the second Symposium on Gas Chromatography held under the auspices of Analysis Instrumentation Division of Instrument Society of America, in June 1959. The possibility of extending the scope and versatility of g.c. has been engaging the attention of workers in this field. The papers described in the book are representative of the present trends of development. They cover a wide range, from improvements in design and performance of g.c. instruments and their components, to newer applications of the technique. The new developments include wider temperature range of operation of columns, *i.e.*, up to 500° C., use of more efficient columns both of packed and capillary type having plate

efficiency of the order of 3/4 of a million theoretical plates. Temperature programming for quick and efficient separation of complex mixtures, and problems connected with use of large-scale columns for preparative separation and purification have also evoked considerable interest. A great deal of effort is directed towards development of more sensitive detectors mostly of the ionization type, and evaluation of their characteristics. Other advances are concerned with development of better types of recorders, integrators and read-out systems, automatic fraction collectors, use of techniques like back flushing, etc.

A few papers deal with application on g.c. to the solution of complex analytical problems like separation of *ortho* and *para* hydrogen, separation and identification of difficultly tractable isomeric mixtures, etc. There is a paper on the use of g.c. for automatic process control.

Two useful features of the book require mention. There is an exhaustive bibliography of over 1,500 references covering from end of 1957 to June 1960. There are also tables of retention values of sample types for some standards columns. These tables will reduce the time and effort involved in the selection of columns for routine analysis.

A highly readable account of the discovery and initial development of gas chromatography by A. T. James, an important collaborator of A. J. P. Martin in this work, is particularly noteworthy.

All the articles in the book are by experts, many of whom are in the forefront in the field of gas chromatography and have already made notable contribution of concepts and techniques. The book is a useful contribution to the field of gas chromatography. It will be valued by all workers engaged in development of g.c. instruments and techniques, and also by persons interested in applying them to complex problems in analysis.

M. V. Bhatt.

Annual Reports on the Progress of Chemistry for 1959. (The Chemical Society, Burlington House, London, W. 1), 1960. Pp. vi + 476. Price £ 2.

Every chemist knows the value of this annual publication issued by the Chemical Society. The present volume (LVI) follows the pattern of the recent previous volumes in this series, and gives the characteristically compact and masterly survey of the progress in almost every branch of chemical research during the year 1959.

Naturally, Organic Chemistry takes up a major share, nearly a third of the volume, and among the topics reviewed in the theoretical section are the chemistry of carbanions and carbenes, in which researches during the year have yielded valuable stereochemical information. Progress in hydroboronation, which has excited wide interest, has been included. The review also contains recent developments in the chemistry of nitrogen-containing derivatives.

In the General and Physical Chemistry section among the topics chosen are Radiation Chemistry, Raman Spectroscopy and Nuclear Magnetic Resonance. In the Inorganic Chemistry section, following the earlier Reports general coverage of work published in 1959, rather than a series of reviews, has been attempted.

The section on Biological Chemistry starts with a review of chemistry of Bone and Tooth minerals. Other topics dealt with are Metabolism of β-carotene ; Chemistry of Muscle Contraction and Relaxation ; and New Amino-acids from Plants. In the Analytical Chemistry section, progress during the year in the fields of Polarography, Absorption and Emission Spectroscopy, and Radiochemical methods has been reviewed.

It is needless to mention that this volume should be in the possession of every library and research department. To enable individual chemists to own a copy the Chemical Society may explore the possibility of issuing paper-cover editions which may prove less expensive.

A. S. G.

Aerosols—Science and Technology. By H. R. Shepherd. (Interscience Publishers, New York and London), 1961. Pp. xiv + 548. Price $ 22.50.

The spectacular advances in the Aerosol industry during the last two decades are apt to blur the fact that the Aerosol technology itself is still in its infancy. But, what vigorous and promising infancy ! The mass of data that has poured in these few years is widely scattered in technical and trade journals, patent specifications, commercial bulletins, house organs and occasionally in popular publications. The time was ripe to garner this scattered harvest, sift and process the material and dish it out in a palatable form. This need is amply served by the book under review which gives an up-to-date and comprehensive picture of Aerosol technology and industry in the United States.

The sixteen chapters in the book are written by nineteen authors—each one of whom has made a significant contribution to the subject on which he writes. So, the book has the stamp of authority. The theory of Aerosols, a variety

of Aerosol products like cosmetics and fragrances, foods, pharmaceuticals, household and industrial Aerosols are handled. Aerosol containers, Aerosol designing and formulation, Aerosol coating compositions and the odour of Aerosols also receive attention. Most important are the two chapters on Valves and Propellants which form the "heart and soul", as it were, of Aerosol application. It is, therefore, all the more surprising that commercial filling techniques of Aerosols should have missed exposition.

A certain amount of overlapping and repetition is perhaps inevitable in such a compilation of contributions by eminent individuals. For example, the method of spray pattern determination is described on pages 145-59 and again on page 283. Similarly, the overrun of foam formulations is fully described on pages 28, 271 and 288 but is repeated on page 418. The Sizzal-spray illustrations on pages 186 and 410 look alike. The statistical data presented relate to the U.S. only. These minor blemishes do not however seriously detract from the worth of this book which is helpful to those engaged in Aerosol technology and industry.

The book is neatly printed, smartly finished and enriched with a number of good photographs. It is to be hoped that its price would not restrict its use in India—for, it is a valuable book.

M. N. SUBBA RAO.

Descriptive Palaeoclimatology. (A collection of papers.) Edited by A. E. M. Nairn. (Interscience Publishers, New York and London), 1961. Pp. ix + 380. Price $ 11.00.

This is a product of the current fashion, a volume containing fourteen papers dealing with various aspects of Palæoclimates, each contributed by different authors. The first two, by A. E. M. Nairn and H. H. Lamb respectively, are introductory and deal with the scope and principles of climatology. The next three are on Desert Sandstones (N. D. Opdyke), Evaporites (Robert Green) and Red Beds (F. B. Van Houten) and their significance in understanding climate. A chapter on the former cold climates (possible ice ages) by R. F. Flint follows. Nairn and N. Thorley deal with some geophysical aspects such as the use of oxygen isotope in determining the temperatures in marine basins in which certain molluscs lived and the connection between palæo-magnetism and climates. The next three papers deal with organisms as possible indicators of climatic conditions—Vertebrates by A. S. Romer, Invertebrates by G. Y. Craig and Plants by R. Karausel. The last four chapters are regional studies of certain major geographic regions—Europe and North America by M. Schwarzbach, the Far East by T. Kobayashi and T. Shikama, Pre-Tertiary Gondwanaland by Lester King, and Tertiary Gondwanaland by E. D. Gill.

In a work of this nature, there would inevitably be some unevenness of treatment, though this is compensated by the fact that each chapter is written by one well versed in the particular aspect. The data available in certain directions are still meagre, for instance in palæo-magnetic and palæo-wind measurements and generalisations from these data may lead to questionable deductions if not controlled by other evidences. On the other hand, the vast amount of factual data on the distribution of animals and plants and their significance could not be adequately dealt with in short papers owing to limitations of space, and have therefore been summarised.

In spite of these limitations, the coverage of the topics is excellent and authoritative and the volume gives a good review of the present status of our knowledge of palæoclimates. One wishes however that the volume could have been larger so as to convey more information to the inquisitive reader. The volume is provided with detailed author and subject indexes which makes it easy to locate the information needed. The printing is exceptionally legible and clear and the get-up excellent. Readers from the less prosperous countries would wish that the cost (presumably around 10 dollars) could have been less if the book had been printed on less heavy paper with less sumptuous binding. The book should be read by all geologists and geophysicists interested in historical geology, palæoclimatology, continental drift and related aspects.

M. S. K.

Swim-bladder Structure of Deep-Sea Fishes in Relation to their Systematics and Biology. By N. B. Marshall. "Discovery" Rep., 31: 1-122. Issued by the National Institute of Oceanography. (The University Press, Cambridge.) Price 55 *sh.* net.

This report by N. B. Marshall of the British Museum (who has considerably contributed to our knowledge of the swim-bladder of fishes as also to biology of deep-sea fishes in several publications) is based on the study of about 90 species of bathypelagic teleosts collected by the "Discovery". Contrary to the view held by some authorities that the swim-bladder or air-bladder could not function in the deep-sea environment owing to high hydrostatic pressure, and therefore,

was absent in them, it has been shown that this organ is commonly present in a number of major groups (Gonostomatidæ, Sternoptychidæ, Myctophideæ and Melamphaidæ) and that these and other fishes also possess highly developed gas-producing structures. It has been brought to light that this organ has a distinctive design in the Stomiatoidea, deep-sea Salmanoidea, Myctophideæ and Anoplogastridæ and within each group variations occur. Certain features like the form of the gas-gland and its position relative to the resorbent area and perhaps also the circulatory system could be used as diagnostic features, *e.g.*, in certain genera of Stomiatoidea. These structures and variations are described for each of the species of fish dealt with. The structures of the swim-bladder and its relationship to systematics have been reviewed for the several orders and families represented. The development of the closed swim-bladder and the evolution of bathypelagic fishes are discussed. It is shown for a number of species that in the larval phase the swim-bladder contains gas but the organ regresses (Miripinnati, certain Stomiatidæ, few Myctophidæ and Melamphaidæ) and in some becomes infested with fat after metamorphosis to the adult form. In certain others the organ is completely absent (*e.g.*, many Stomiatoids, Alepocephalidæ, etc.). After considering the structure of the swim-bladder wall, the author discusses the functional, morphological and biological aspects as well as relationship of the organ to vertical distribution and vertical migration in the light of his own researches and earlier observations.

Space limits further ingression into many details embodied in this account, considerable bulk of which is original. Suffice it to say that the account, an outstanding contribution to our knowledge of these denizens of the deep, is well presented and profusely illustrated, and would be welcomed by all interested in the biology of fishes.

R. SUBRAHMANYAN.

Microbial Reaction to Environment. Edited by G. G. Meynell and H. Gooder. (Cambridge University Press, London, N.W. 1), 1961. Pp. ix + 416. Price 42 *sh.*

This volume records the papers presented in London at the Eleventh Symposium of the Society for General Microbiology in 1961. As in the previous volumes, a number of interesting topics have been discussed by microbiologists who have distinguished themselves in different aspects of microbial reaction to environments.

There are fifteen contributions and they cover practically all the important aspects of microbial behaviour unaccompanied by alterations in their genetic structure. Most of them are well documented and include both historical and current information on the subject. Relatively newer developments in the subjects as (1) The effect of environment on the formation of bacterial flagella; (2) The influence of environment on the radio-sensitivity of micro-organisms; (3) Synchronization of division in cultures of *Saccharomyces cerevisiæ* by control of the environment; (4) Environmental influence on genetic recombination in bacteria and their viruses; and (5) Antibiotic production as an expression of environment have also been discussed.

The book presents an up-to-date account of knowledge and would prove useful to both students and research workers as it contains topics which have not been reviewed recently and which offer possibility of much rewarding research.

J. V. B.

Cotton in India—A Monograph, Vol. IV. By S. M. Sikka, Arjan Singh, Avtar Singh, P. D. Gadkari, R. Balasubrahmanyan, N. K. Iyengar, K. Sawhney, V. K. Bederker, G. B. Patel, P. S. Pandya, V. N. Paranjpe and N. S. Panigrahi. (Indian Central Cotton Committee, 14, Nicol Road, P.B. No. 1002, Bombay-1), 1961. Pp. 373. Price Rs. 30.

This volume, the last in the series, covers practically the same ground dealt with in the first three volumes, somewhat more elaborately with special reference to the six recognised cotton regions of the country. These regions are: (*i*) Northern *hirsutum-arboreum* region; (*ii*) Central *arboreum* region; (*iii*) Southern *hirsutum-arboreum* region; (*iv*) Central *herbaceum-arboreum-hirsutum* region; (*v*) Western *herbaceum* region and (*vi*) Eastern region. Full information is given region-wise on soil and climate, statistics of area and production, cultivation practices, results of agronomic investigations, important pests and diseases and recognized control measures, progress of breeding work, description of improved varieties and their coverage. Information is also provided on seed multiplication work, cotton legislation, marketing and economics of cotton production with special reference to each region and even individual States comprising each region. Except that the present volume brings together all information regarding cotton growing in different parts of India separately, much of it could have been incorporated in the chapters dealing with

the subject in the earlier volumes. For example, information on Physiology of the cotton plant could well have gone into Chapter I and similarly information on diseases and pests into Chapters III and IV respectively of Volume II.

The volume provides critical data on the relative importance of the different regions with regard to total production as well as production according to quality. In giving lint lengths which determine quality, the production figures of American and desi cottons are however lumped together instead of separately. Of the regions the eastern region is of very minor importance at present, but the new areas brought under irrigation in Orissa and West Bengal offer great potentialities for increasing production. The volume is very well illustrated with a number of charts and photographs of typical plants of the different improved varieties of cotton now under cultivation. For one not much interested in the fundamentals, the present volume by itself provides all information on Cotton in India.

K. R.

Advances in Morphogenesis, Vol. 1. Edited by M. Abercrombie and Jean Brachet. (Academic Press, New York and London), 1961. Pp. xiii + 445.

The book is the first volume in this new Series whose main object is to link up the various branches of biology dealing with development. It comprises 9 chapters, each written by an expert in his field of study.

In Chapter 1, Dr. Tuneo Yamada discusses the problem of organizer (as distinct from agent or factor) and opines that an essential understanding of its action will be obtained only when the first biochemical or biophysical changes evoked by the inducing agent within the cell are known.

The Ascidian egg is significant in that it can remain in unfertilized condition in the oviduct for a long time without undergoing any divisions and that its mode of development is intermediate between the mosaic type and the regulative type. These peculiarities have been thoroughly exploited by Dr. G. Reverberi who has analysed the egg constituents and discussed in Chapter 2 their significance in morphogenesis. The next two chapters are devoted to regeneration of appendages and tissue and are interesting reading even to the non-expert.

In plants, unlike animals, the capacity to produce the plant body does not reside in the zygote alone, it may well persist in almost any living cell of the entire plant body. For this reason Prof. F. C. Steward and Dr. H. Y. Mohan Ram have reviewed the relevant work on plant cells with a view to understand factors determining cell growth in Chapter 5 that is the only chapter contributed by botanists. Herein it is concluded that once cells are endowed by their origin, with that deep-seated or 'built-in' capacity to grow, the manner in which this is expressed is controlled by regulatory substances within certain limits imposed by genetic machinery.

In the next chapter Dr. C. E. Wilde Jr. discusses the differentiation of vertebrate pigment cells that have long been favourable material for investigation of cell behaviour and the processes of migration, distribution and differentiation. Chapters 7 and 8 deal with the morphogenesis of vertebrate limb and eye respectively and in the last chapter Dr. Ch. Devillers discusses the structure and dynamic aspects of the development of the teleostean egg.

Every chapter begins with a repetition of its contents and is followed by a detailed and up-to-date bibliography that is not necessarily complete. At the end there is the Author Index and Subject Index. The book has a get-up of high standard and the reproduction of figures too, though few, is good.

I wish the editors had invited a few more botanical contributions for the simple reason that the problem of morphogenesis in plants is comparatively simple (?), and the information gained there may be useful in the solution of complex problems in animals.

Most chapters are reviews that deal primarily with the work of the contributors and as such they are intended for workers in their respective fields. But it is hoped that the information so gathered will be reviewed subsequently for much wider use. As it is, the book is a standard reference work on this vital and ever-increasing subject of morphogenesis.

V. Puri.

Information Retrieval and Machine Translation. Part 2. Edited by Kent (Allen). (*Advances in Documentation and Library Science*, 3·2). (Interscience Publishers, New York and London), 1961. 23 × 15 cm. Pp. 12 + 600. Price $ 25.00.

This is the second part of the transactions of the International Conference for Standards on a Common Language for Machine Searching and Translation, sponsored by Western Reserve University and Rand Development Corporation and held in Cleveland, Ohio, from 6 to 12th September 1959.

This Conference is a symptom of the crisis developing in the world of research. Research has now become a social necessity as a result of population pressure exceeding the capacity of natural and near-natural commodities. Research cannot any longer be left solely to the prompting of an inner urge in exceptional men of genius appearing occasionally. On the other hand, the work of many a man of genius has to be followed up by a world-wide team of intellectuals of all grades, so as to exploit it fully for social benefit. Therefore, the annual research output runs to millions of micro documents appearing as articles in periodicals. This cascade creates the new problem of avoiding unintended and unnecessary repetition of the same item of investigation by different teams of workers. Its avoidance calls for organising the research output in such a way that each item is brought to the notice of the concerned research teams promptly, pin-pointedly, and exhaustively, so that it can be carried to a further stage of research. This new responsibility falls to the share of the library profession and it is called documentation.

The efficiency of documentation depends on the design of a system of expressive, co-extensive class-numbers to represent each micro thought uniquely. In certain circumstances, speed of the retrieval of the documents relevant to a particular problem on hand needs the use of machinery. In its turn, the machinery calls for class-numbers to be translated into machine code symbols. Thus, the library profession is now engaged in the development of two artificial languages—the classificatory language and the machine language. The object of the Conference was to explore the possibility of designing the two languages in relation to each other so as to avoid the wastage involved in transitioning from the one to the other. This is the first international attempt of the kind. It cleared the ground for future work.

The Conference was attended by about 200 persons from ten countries. India was represented by one delegate. This part includes 39 out of the 61 papers presented at the Conference. Five of these are on design of machinery for information retrieval; 21 concern themselves with machine translation; and the remaining 13 overlap both these fields. Two of the 39 papers are contributions from India. They are entitled *Natural, Classificatory, and Machine Languages, and Classification and Retrieval* respectively.

The last 45 pages of the text contain the decision made for future action. An International Continuing Committee was formed with B. C. Vickery (England) as Chairman, Allen Kent (U.S.A.) as Secretary, and representatives from each of the ten participating countries. One of the three Vice-Presidents was selected from India. Four sub-committees were set up to stimulate work on each of the following subjects :—

1. Standardisation of terminology and nomenclature with S. R. Ranganathan (India) as Chairman;
2. Exchange of materials and information, with S. N. Alexander (U.S.A.) as Chairman;
3. Exchange of personnel, with Chairman to be named by U.S.S.R.;
4. Research with E. de Grollier (France) as Chairman.

S. R. RANGANATHAN.

Books Received

From : Interscience Publishers, 250, Fifth Avenue, New York-1 :

Pharmaceutical Analysis. Edited by T. Higuchi and Einar Brochmann-Hanssen, 1961. Pp. ix + 854. Price $ 28.50.

Metallurgical Society Conferences (Vol. 10). *Columbium Metallurgy.* Edited by D. L. Douglass and F. W. Kunz, 1961. Pp. xvi + 746. Price $ 26.00.

Treatise of Analytical Chemistry. Part II. *Analytical Chemistry of the Elements* (Vol. 5). Edited by I. M. Kolthoff and Philia J. Elving, 1961. Pp. xxi + 409. Price $ 13.75.

From : Academic Press, Inc., 111, Fifth Avenue, New York-3, N.Y.; India : Asia Publishing House, Bombay-1 :

The Quantum Mechanics of Many-Body Systems. By D. J. Touless, 1961. Pp. ix + 175. Price 45 *sh.*

Methods of Celestial Mechanics. By D. Brouwer and G. M. Clemence, 1961. Pp. xii + 598. Price $ 15.50.

Fuel Element Fabrication with Special Emphasis on Cladding Materials, Vol. I. Pp. xi + 538. Price 100 *sh.*; Vol. II. Pp. xii + 384. Price 71 *sh.* 6 d.

From : Butterworth and Co., 88, Kingsway, London, W.C. 2 :

Progress in Organic Chemistry. Edited by J. W. Cook and W. Carruthers, 1961. Pp. viii + 172. Price 50 *sh.*

Diffusion and Heat Flow in Liquids. By H. J. V. Tyrrell, 1961. Pp. xii + 329. Price 65 *sh.*

Systematic Qualitative Analysis—An Introduction. By G. A. Morrison, 1961. Pp. ix + 198. Price 65 *sh.*

Cybernetics—Control and Communication in the Animal and the Machine (Second Edition). By N. Wiener. (The M.I.T. Press and John Wiley and Sons, New York-16, N.Y.), 1961. Pp. xvi + 212. Price $ 6.50.

British Medical Bulletin—Human Genetics. (Vol. 17, No. 3). (The Medical Department, The British Council, 65, Davies Street, London, W. 1), September 1961. Pp. 177-264. Price 20 *sh.*

Dispersion Relations and the Abstract Approach to Field Theory. Edited by Lewis Klein. (Gordon and Breach Science Pub., Inc., 150, Fifth Avenue, New York-11, N.Y.), 1961. Pp. x + 273. Price $ 4.95.

Progress in Nuclear Energy—Reactors. (Vol. 2). Edited by H. R. McK. Hyder. (Pergoman Press, Headington Hill Hall, Oxford), 1961. Pp. vi + 557. Price £ 5-5 *sh.*

Agriculture Monograph 25—Atlas of Avian Hematology. By A. M. Lucas and C. Jamroz. (Regional Poultry Res. Lab., Animal Husbandry Research Division, East Lansing, Mich.), 1961. Pp. vi + 271. Price not given.

SCIENCE NOTES AND NEWS

Award of Research Degree

Osmania University has awarded the Ph.D. degree in Botany to Shri Pannuri Ramarao for his thesis entitled "Seasonal Variation, Distribution and Taxonomy of Micro-Fungi in Soils of Hyderabad".

Symposium on Plant Tissue and Organ Culture

A Symposium on Plant Tissue and Organ Culture organized jointly by the University of Delhi and UNESCO South Asia Science Co-operation Office, Delhi, will be held at the University of Delhi from December 22-29, 1961.

Tissue and organ culture promises to throw light on several problems of fundamental value concerning growth and metabolism, including physiology of fruit growth. It can also be exploited in overcoming the barriers to cross-ability, and induction of parthenogenesis and polyembryony. During the past 20 years work on these lines has been initiated in several laboratories in different parts of the world, and very useful results obtained even in preliminary trials. The Symposium will not only enable workers in South Asia to exchange views and discuss their problems with foreign experts, but will also help them in a correct appraisal of the work in progress in other countries.

Invitations have been extended and accepted by the following international experts on behalf of UNESCO: (1) Professor J. P. Nitsch, France; (2) Professor J. Reinert, West Germany; (3) Professor F. C. Steward, U.S.A.; (4) Professor H. E. Street, U.K.

An Organizing Committee under the chairmanship of Professor P. Maheshwari, Professor of Botany, Delhi University, has been constituted.

Further information in connection with the Symposium can be obtained from: Mr. J. Swarbrick, Acting Director, UNESCO South Asia Science Co-operation Office, 100, Sundar Nagar, New Delhi (India).

Rotating-Wall Laboratory for Building Research

A rotating-wall laboratory for research into heat transfer through different types of walling material under varying conditions of exposure has been built for Britain's Department of Scientific and Industrial Research (DSIR) station at Garston, near Watford, southern England. A model of the laboratory, which can be rotated through a full circle, is to be shown at the Building Exhibition at Olympia, London, from November 15 to 29. The rotating wall of the laboratory should enable scientists to calculate space heating with greater accuracy than before.

Another model to be shown on the Ministry's stand is the DSIR's anechoic chamber and reverberant room. This chamber is thought to be the largest anechoic chamber in Europe. It is entirely without an echo, and is to be used, among other things, for research into transmission of sound from partition walls.—(*British Information Service.*)

Memoirs of the Indian Botanical Society

The Indian Botanical Society brings out in addition to its well-known quarterly the *Journal of the Indian Botanical Society* which is now running its 40th volume, special publications of great value giving a connected account of the latest developments in different branches of botanical research. Among these priced publications are the *Memoirs of the Indian Botanical Society* three of which have so far come out

under the editorship of Prof. T. S. Sadasivan. Memoir 1 (1958, pp. 159, Price Rs. 8.50) contains the papers presented at the three Symposia of the Botany Section of the Indian Science Congress in 1958. They are "Modern Trends in Plant Taxonomy"; "Physiology of Micro-organisms"; and "Floristic Studies in India".

Memoir 2 (1960, pp. 101, Price Rs. 7·50) contains the Papers contributed to the Symposia on "Tissue and Organ Culture of Plants", and "Carbohydrate Metabolism" of the 1959 Indian Science Congress.

The latest publication in this series, namely, Memoir 3 (1961, pp. 210, Price Rs. 14·50) pertain to the Symposia on "Distribution Pattern of Plants in India" and "Effect of Chemicals on Cell Division" of the 1959 ISC, and on "Dynamics of Soil Fungi" and "Recent Advances in Angiosperm Morphology" of the 1960 Congress. These symposia articles thus made available in compact volumes will be useful not only to the specialist research workers in the various fields of plant science, but also to teachers and students of the universities in India and elsewhere.

Structural Materials in Chemical Technology

"Werkstoffe in der chemischen Technik" is the title of Volume 39 of the series of *Dechema Monographs* which has just been published by the Verlag Chemie GmbH., Weinheim/Bergstrasse (286 pages, Price DM 24·80; to members DM 19·80). The present volume contains the text of 16 lectures which were presented at the Dechema Annual Meeting 1960. Each of the lectures is based on a different theme in the field of structural material techniques and particular value is attached to discussing applications in the most important problems. The subjects covered include the prevention of metallic corrosion, the prevention of boiler scale, the use of noble metals in the construction of plant, the properties of cladded materials, the use of acid and heat resisting substances as well as of plastics materials in Chemical Technology and in the control of quality of chemical plant. A discussion on structural materials for the building of rockets is of general interest.

Summaries of the individual lectures in English and French are included. A subject index completes the volume.

World Population Trends

The methods used by the United Nations Organization in preparing population statistics of the different countries are explained in the *UNO Demographic Yearbook* 1960. The yearbook includes a table which shows the populations of each political area in every year since 1920. The total population of the world in 1959, is estimated as between 2,835 and 2,964 millions. Of this nearly one half, between 1,416 and 1,508 millions, is now concentrated in four countries China, India, U.S.S.R. and U.S. The other areas of the world have an estimated population between 1,431 and 1,476 millions. India's population is known within 11 millions, and that of USSR and US within 3 millions. The uncertainty about the population of China is the major factor in the range.

It is estimated that the rate of growth may lie between 1·5 and 2% per annum, resulting in a total annual increase of 44-55 millions.

Oxygen Intake by the Roots of Rice Plant

The physiology of the rice plant and its nutritional requirements pose a problem which needs thorough investigation. It is known that nearly all plants need oxygen in the soil in their root zone. Whereas the leaves of plants take in oxygen only at night—during the day in the presence of sunlight they absorb carbon-dioxide from the atmosphere—so far as the roots are concerned there is a continuous intake of oxygen from the soil. If the soil pores are blocked by flooding, oxygen from the atmosphere cannot get into the soil and the roots are starved of their oxygen supply. The question arises: how does the rice plant which is generally grown on marshy or flooded land—sometimes under several feet of water—cope with the situation? Further, flooding induces chemical changes in the soil some of which are known to be unsuitable for plant growth. But these do not seem to affect the rice plant. Rice seems to have peculiarly adapted itself to withstand a variety of unusual conditions.

Radio-isotopes offer an effective technique for the study of the metabolic mechanism in rice. Experiments with the help of radio-active carbon C-14, have led to some interesting results, although not yet conclusive, regarding the intake of oxygen by the roots of the rice plant. They suggest that rice has a mechanism whereby hydrogen peroxide is excreted from its roots. This hydrogen peroxide releases oxygen, thereby maintaining the oxygen supply in the neighbourhood of the roots.—(*IAEA Bulletin*).

Atlantic Undercurrent

Ever since a submerged equatorial flow—the Cromwell Current—was discovered in the Pacific a few years ago, oceanographers have been expecting to find an under-current in the Atlantic and possibly in the Indian Ocean as well.

Recently Arthur D. Voorhis of the Woods Hole Oceanographic Institution, during a cruise of the research vessel *Chain*, identified a subsurface current in the Atlantic Ocean. It appears to flow eastward along the equator at a depth of about 100 metres in a belt extending from 1–2° south of the equator to 1–2° north, very much like the Cromwell Current. The speed of the Atlantic current is estimated at 2 knots, as against a speed of 2½–3 knots for the Cromwell Current.

—(*Scientific American*, September, 1961).

Steroids as Ice Nucleators

Substances that are usually suggested as possible ice nuclei for cloud seeding are inorganic compounds of hexagonal structure with lattice parameters similar to those of ice. The discovery of a class of organic materials capable of acting as ice nuclei appears to be novel. R. B. Head of the C.S.I.R.O. Chemical Research Laboratories, Melbourne, finds that some steroids can as effectively nucleate ice as silver iodide.

In the investigation activities to nucleate ice were determined by means of a microscope cold stage into which slides carrying steroid particles could be inserted. Provision was made for the introduction of moist air. The particles under test thus acted as freezing nuclei.

The most active steroids found by Head were androsterolone, testosterone, 3 α-methylcholestan-3 β-ol, androsterone, pregnenolone, androstan-3, 17-dione, and cholesterol. It was found that droplets smaller than about 0·03 mm. diameter were usually inactive, and nucleation of all particles larger than 0·03 mm. was complete at $-7°$ C.

It is usual to associate nucleation with the similarity in spacing between the ice lattice and that of the nucleating substance. Although the exact crystal structures of many steroids are still unknown there are evidences to believe that the molecules in the majority of steroidal structures are arranged in parallel stacks with head-to-tail packing. One surface of the stack would thus present a pattern of alternating hydroxy groups and sidechains. It is presumed that nucleation takes place on this surface. It is also significant that the cross-sectional dimensions of the steroid molecule, viz, 5 ± 1 Å $\times 7 \pm 1$ Å suggests a possible compatibility with the prism face of ice, 4·5 Å $\times$ 7·35 Å.

It is also found that the steroids most active in nucleation have keto or hydroxy groups at position 3, and many of them have keto groups at position 17, in addition. If it is assumed that the essential requirement for activity is a hydroxy or keto group at position 3, it is clear why no activity is shown by the steroid esters since esterification occurs at this position.—(*Nature*, 1961, 191, 1058.)

A New Hypothesis for the Origin of Lunar Domes

The problem of the origin of lunar domes is one which appears to lend itself most readily to solution by analogy with terrestrial features. To the number of hypotheses currently in vogue for the origin of the lunar domes J. W. Salisbury of the Air Force Cambridge Research Laboratories, Bedford, Mass., has added one more, namely, the mineral phase-change expansion hypothesis. This mechanism was first proposed by Hess for terrestrial domes and uplifts.

Hess presented evidence to show that the materials below the Mohorovicic discontinuity is peridotite and that, for a considerable depth beneath the Moho the temperature will be below 500° C. He then used the Bowen and Tuttle data on the $MgO—SiO_2—H_2O$ system to show that serpentinization of olivine would occur at temperatures of 500° C. or less, provided that water could be introduced into the system.

$$\text{Olivine} + \text{Water} \rightleftarrows \text{serpentine} + \text{heat}.$$

The change from olivine to serpentine involves approximately a 25% increase in volume, which would be more than adequate to produce domical structures.

In order to have the same mechanism of uplift active in the moon we must assume peridotitic material to be present in temperature region below 500° C. with subsequent introduction of water vapour.—(*Astrophys. Jour.*, 1961, 134, 126.)

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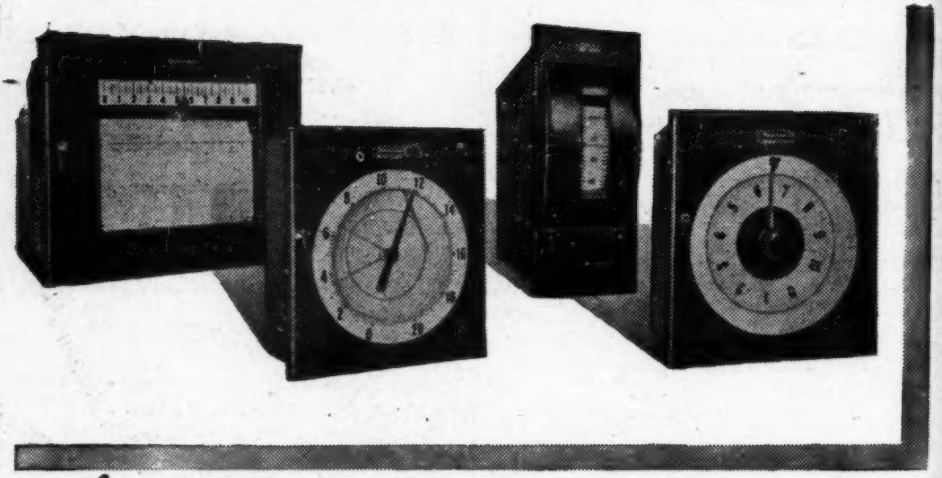

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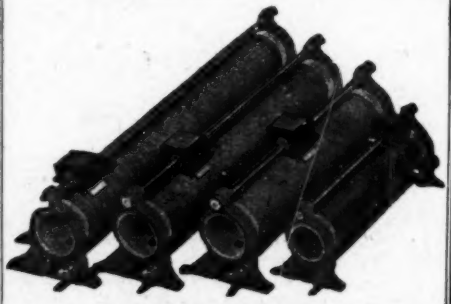

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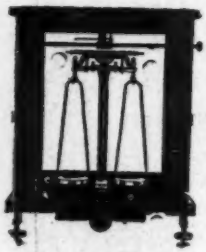

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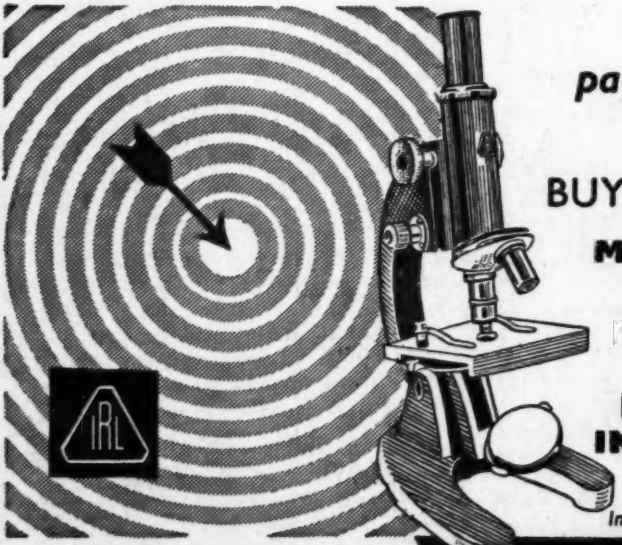

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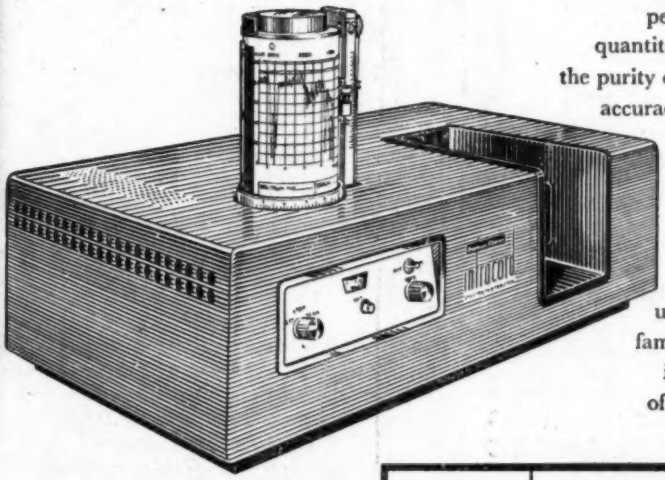

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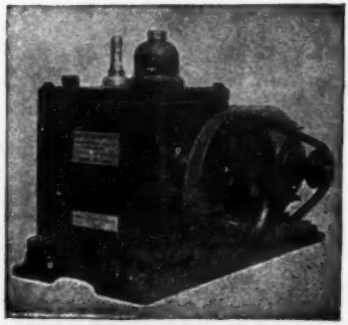

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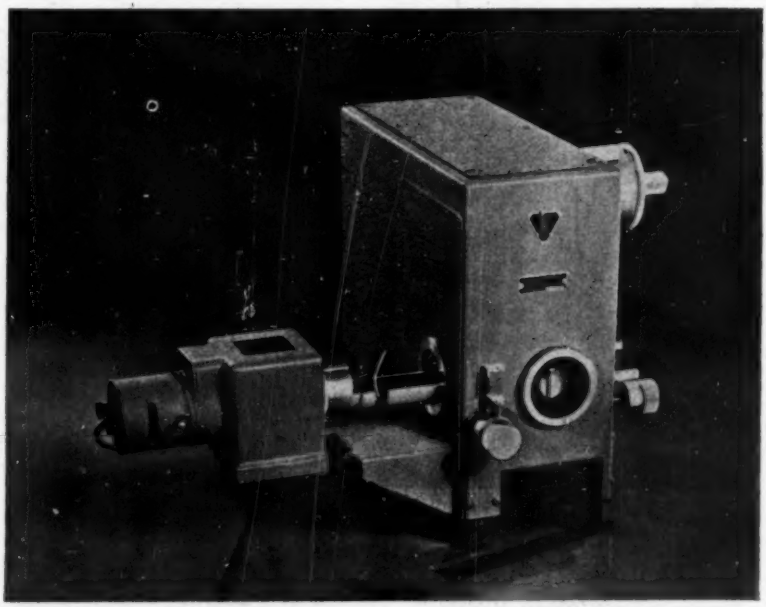

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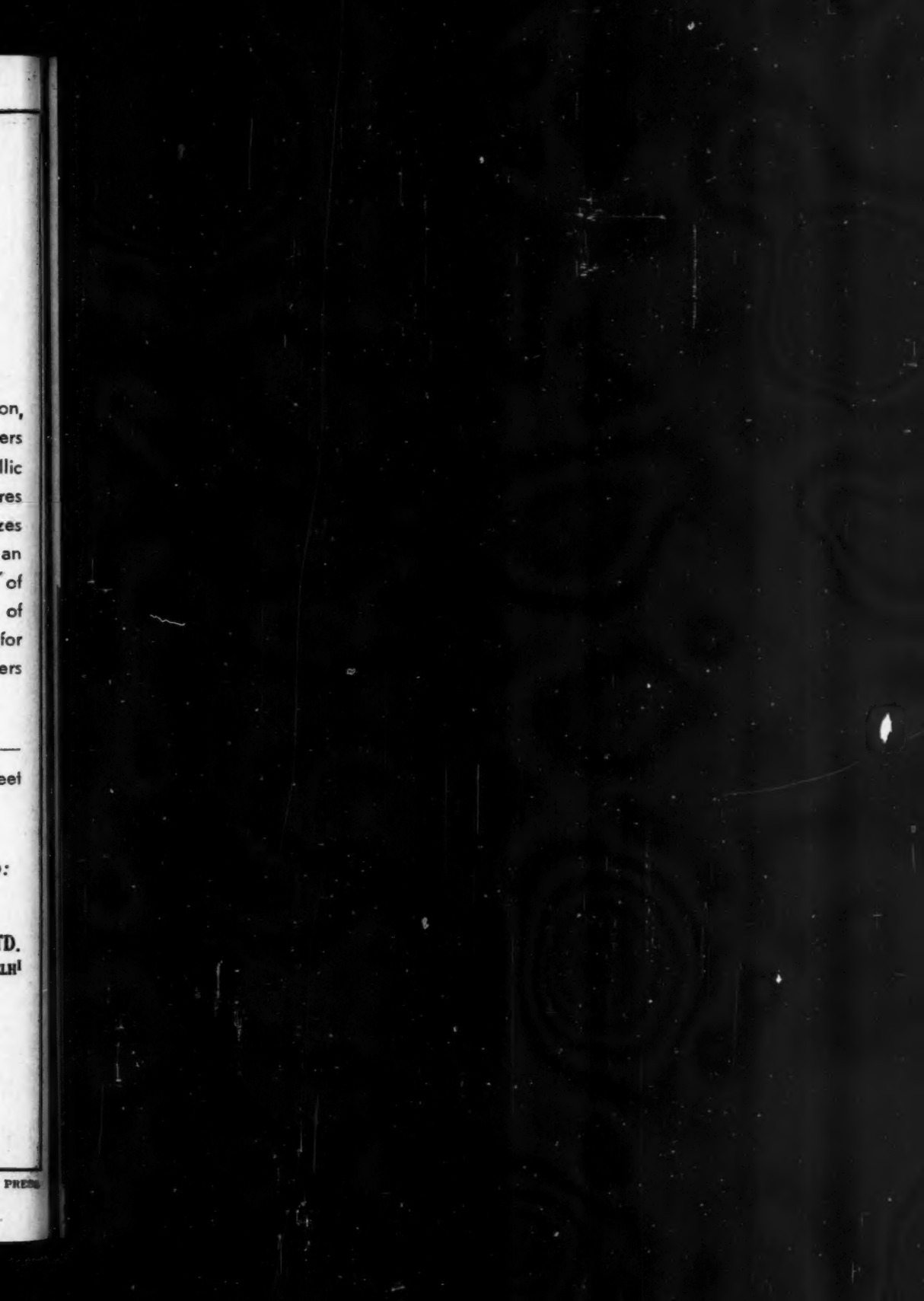
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